U. S. DEPARTMENT OF AGRICULTURE.

ANNUAL REPORT

OF THE

OFFICE OF EXPERIMENT STATIONS

FOR

THE YEAR ENDED JUNE 30, 1902.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1903.

51602

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To the Senate and House of Representatives:

I transmit herewith the annual report of the Office of Experiment Stations, prepared under the direction of the Secretary of Agriculture, which includes a report on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1902, in accordance with the act making appropriations for the Department of Agriculture for the said fiscal year.

The attention of Congress is called to the request of the Secretary of Agriculture that 5,000 copies of the report be printed for the use of the Department of Agriculture, and that provision be made to print such a report annually.

THEODORE ROOSEVELT.

WHITE HOUSE, *January 19, 1903.*

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Office of the Secretary,
Washington, D. C., January 15, 1903.

Sir: I have the honor to transmit herewith the annual report of the Office of Experiment Stations, prepared in accordance with my instructions. This includes a report on the work and expenditures of the agricultural experiment stations established under the act of Congress of March 2, 1887, for the fiscal year ended June 30, 1902, in compliance with the following provision of the act making appropriations for this Department for the said fiscal year:

> The Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of the said act of March second, eighteen hundred and eighty-seven, shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of the said act, and shall make report thereon to Congress.

Reports are also included on the experiment stations in Alaska, Hawaii, and Porto Rico, which are provided for in the appropriation act aforesaid and are directly managed by this Department.

If this report is published by Congress, it is desirable that 5,000 copies should be provided for the use of this Department, and that provision be made to print such a report annually.

I have the honor to be, sir, your obedient servant,

James Wilson,
Secretary.

The President.

LETTER OF SUBMITTAL.

OFFICE OF EXPERIMENT STATIONS,
Washington, D. C., January 12, 1903.

SIR: I have the honor to present herewith the annual report of the Office of Experiment Stations, which includes a report on the work and expenditures of the agricultural experiment stations in the United States for the fiscal year ended June 30, 1902.

This is the eighth annual report on the work and expenditures of the agricultural experiment stations in the United States, made by the Director of the Office of Experiment Stations, under instructions from the Secretary of Agriculture. As heretofore, the report is based on three sources of information, viz, the annual financial statements of the stations, rendered on the schedules prescribed by the Secretary of Agriculture, in accordance with the act of Congress; the printed reports and bulletins of the stations, and the reports of personal examinations of the work and expenditures of the stations made during the past year by the Director, assistant director, and one other expert officer of the Office of Experiment Stations.

In addition to the brief accounts of all the stations, the detailed reports of the special agents in charge of the stations in Alaska, Hawaii, and Porto Rico, and summary statements regarding the special investigations in charge of this Office have been included, together with special articles on some features of recent progress in agricultural education, farmers' institutes in the United States, popular editions of station bulletins, and cooperative experiments in the United States and Canada. In the preparation of the statistical portions of this report Miss M. T. Spethman, of this Office, has rendered valuable assistance.

Very respectfully,

A. C. TRUE,
Director.

Hon. JAMES WILSON,
Secretary of Agriculture.

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ANNUAL REPORT OF THE OFFICE OF EXPERIMENT STATIONS, JUNE 30, 1902.

WORK AND EXPENDITURES OF THE AGRICULTURAL EXPERIMENT STATIONS.

By A. C. True and D. J. Crosby.

SUMMARY.

STATISTICS OF THE STATIONS.

Agricultural experiment stations are now in operation under the act of Congress of March 2, 1887, in all the States and Territories and in Alaska, Hawaii, and Porto Rico. In Connecticut, New Jersey, New York, Hawaii, Missouri, Alabama, and Louisiana separate stations are maintained wholly or in part by State funds. A number of substations are also maintained in different States. Excluding the substations, the total number of stations in the United States is 60. Of these, 53 receive appropriations provided for by act of Congress.

The total income of the stations during 1902 was $1,328,847.37, of which $720,000 was received from the National Government, the remainder, $608,847.37, coming from the following sources: State governments, $369,771.12; individuals and communities, $2,301.38; fees for analyses of fertilizers, $80,942.36; sales of farm products, $105,644.60; miscellaneous, $50,187.91. In addition to this the Office of Experiment Stations had an appropriation of $139,000 for the past fiscal year, including $12,000 for the Alaska experiment stations, $12,000 for the Hawaiian investigations, $12,000 for the Porto Rico investigations, $20,000 for nutrition investigations, and $50,000 for irrigation investigations. The value of additions to the equipment of the stations in 1902 is estimated as follows: Buildings, $176,113.78; libraries, $11,941.98; apparatus, $19,727.94; farm implements, $14,982.56; live stock, $20,554.27; miscellaneous, $19,509.09; total, $262,829.62.

The stations employ 710 persons in the work of administration and inquiry. The number of officers engaged in the different lines of work is as follows: Directors, 53; assistant and vice-directors, 18; special

agents in charge, 3; chemists, 151; agriculturists, 54; agronomists, 7; animal husbandmen, 25; horticulturists, 73; farm foremen, 25; dairymen, 34; botanists, 50; entomologists, 50; zoologists, 6; veterinarians, 27; meteorologists, 12; biologists, 8; physicists, 5; geologists, 4; mycologists and bacteriologists, 20; irrigation engineers, 9; in charge of substations, 14; secretaries and treasurers, 25; librarians, 10; clerks and stenographers, 41. There are also 103 persons classified under the head of "miscellaneous," including superintendents of gardens, grounds, and buildings; apiarists; vegetable, plant, and animal pathologists; herdsmen, poultrymen, etc. Three hundred and sixty-four station officers do more or less teaching in the colleges with which the stations are connected.

The activity and success of the stations in bringing the results of their work before the public continue unabated. During the year they published 373 annual reports and bulletins—many more than are required by the Hatch Act. These were supplied to over half a million addresses on the regular mailing lists. A larger number of stations than formerly supplemented their regular publications with more or less frequent issues of press bulletins, and most of the stations report a large and constantly increasing correspondence with farmers on a wide variety of topics.

During the year a number of new institutions for investigations in agriculture have been established. The Virginia State board of agriculture has established at Saxe, Charlotte County, an experimental farm for the purpose of making fertilizer tests in accordance with the State fertilizer law. The Mississippi legislature has appropriated $13,000 for a new substation, which has been located at McNeill on a 2,000-acre tract of donated land. A new Texas substation, for which the State legislature appropriated $10,000, has been located at Troupe, in Smith County. The Kansas Experiment Station has finally come into possession of 3,500 acres of the Fort Hays Reservation and has established there a substation supported by State funds. The Agricultural Epitomist Experiment Station has been recently established at Spencer, Ind., on a farm of 500 acres owned and conducted by the company which publishes the Agricultural Epitomist.

PROGRESS OF THE STATIONS.

The feature of the progress of agricultural institutions in this country which has attracted most attention during the past year is the rapid increase in the public interest in these institutions. This is shown in the increase in the number of students in agricultural colleges and schools, in the larger attendance at the farmers' institutes, in the enlarged correspondence and mailing lists of the stations, in the increased demand for trained workers in agricultural and other business enterprises requiring scientific and expert knowledge and skill for their

most successful management, and in the wider space given to agricultural education and research in agricultural and other journals.

Evidences of the influence of station work in improving agricultural practice and benefiting the farming interests of the country continue to multiply. This influence is felt in all of the various phases of agricultural operations. It is possible here to briefly refer to only a few recent examples of the practical benefits which are being derived from investigations by the experiment stations.

The origination and introduction of improved varieties of cereals through the agency of the stations of the grain-growing region, cooperating with this Department, are resulting in a vast increase in the grain-producing capacity of the country. As an illustration of this it may be cited that a variety of oats imported by the Department and tested and improved by the Wisconsin Station, among others, has been widely distributed and grown, with results which indicate that its general introduction will be followed by an average increase of yield which may be safely estimated at from 3 to 5 bushels per acre. As the acreage of oats in Wisconsin alone in 1901 was 2,290,288, producing 66,647,381 bushels, worth $25,992,479, this would mean a gain to the farmers of Wisconsin annually of from $2,400,000 to $4,400,000 on the oat crop alone.

Marked improvement in the yield and quality of wheat in the Northwestern States is resulting from the distribution of improved varieties originated at the Minnesota Station. One of the results of the work of the Illinois Station on the breeding of corn has been the formation of the Illinois Seed Corn Breeders' Association, a chartered organization, with a limited membership of reputable and well-known corn growers, pledged to select and grow their seed corn according to definite rules formulated by the station and to sell only their own crop. The success of this enterprise has been phenomenal. All of the available supply of the improved seed is rapidly disposed of to farmers, and much of it is engaged in advance. The work of this station on corn is proving to be far-reaching in its results, not only in improving the general quality of seed corn, but in inducing practical men to undertake breeding for special qualities—for protein, for oil, or for starch—which the station has demonstrated to be entirely feasible. The influence of station investigations is also being widely exerted in the grain-growing region in the introduction of rotations to conserve soil fertility in place of the exhaustive system of continuous grain cropping heretofore generally followed.

The beneficial effects of the work of the stations in the older States on fertilizers are becoming every year more apparent in the economical purchase and intelligent use of fertilizers by farmers. For example, as a direct result of the investigations and advice of the New Jersey Station, organizations of farmers have been formed in the truck-

growing districts of that State for the purchase of unmixed fertilizing materials, thus effecting a saving of from 25 to 40 per cent in the cost of their fertilizers and at the same time securing better results as regards earliness, yield, and quality of product.

The recent introduction into a number of States of a system of inspection of feeding stuffs by the stations, similar to that which has been in force for some time for fertilizers, furnishes a very effective means of protecting farmers against fraud and of inculcating correct ideas regarding feeds and feeding. It is encouraging to note that in many States farmers are now following very closely the advice of the stations regarding the purchase of concentrated feeds and the balancing of rations made from home-grown products.

The rapid extension of the rational use of silage and the very general adoption of the round form of silo are directly traceable to experiment-station influence.

Through the efforts of the Department and the stations, the application of insecticides and fungicides as means of protection against injurious insects and plant diseases has become almost universal, and the benefits and profits resulting from the practice are no longer questioned. Striking evidence of the readiness with which farmers and fruit growers will now adopt promising means of plant protection is furnished by the fact that the method of formaldehyde treatment of smut of oats, proposed by one of the stations, was almost immediately put into use by over 25,000 farmers in the State of Wisconsin alone, with the prospect that the number using the method will rapidly increase the next year. As the estimated loss from oat smut in Wisconsin varies from $3,000,000 to $7,000,000 annually, according to the season and other conditions, the value of an effective means of prevention of the disease can be readily estimated.

The Utah Station has achieved notable success in its study of the extent to which dry farming—that is, farming on lands in the arid regions which can not be irrigated—may be practiced with profit and the conditions necessary to success. This work is bearing fruit in the rapid extension on a safe basis of what has heretofore been a very precarious system.

COOPERATION OF THE STATIONS WITH THE DEPARTMENT.

During the past year many cooperative enterprises between the different bureaus and divisions of this Department and the experiment stations have been continued, and contracts have been made for a considerable number of new investigations on this plan. In order to more clearly define the conditions under which such cooperative arrangements should be made, a plan was formulated for conducting this work and transmitted to the directors of stations as well as to the chiefs of bureaus and divisions of the Department. This has cleared away some

difficulties hitherto attending arrangements with the stations, and especially has defined the responsibilities of both the Department and the stations in such enterprises.

As the number of calls for cooperative work have increased, it has become clear that in many instances the limited funds of the stations will not permit them to give any direct financial support to any considerable number of such enterprises. Often the only contribution they are able to make is the limited service of officers already largely engrossed in other work, and in some cases office and laboratory facilities. The proper adjustment of the financial obligations necessarily involved in the cooperative enterprises between the Department and the stations is a problem which still requires much careful consideration.

Among the cooperative enterprises now under consideration are the following: Investigations on the improvement of pastures and desert ranges; grasses and forage plants for arid regions; planting and testing of sand-binding plants; tests of novelties introduced by the seed trade; cereal investigations; investigation of the gluten content of wheat; nutrition investigations; irrigation investigations; growing of sugar-beet seed; soil survey; statistics relating to cost of growing field crops and to farm management; curing of cheese at low temperatures; studies of the codling moth, insects injurious to forest trees, and the relation of insects to the health of man.

NUMEROUS CHANGES IN THE PERSONNEL OF THE STATIONS.

During the past year there have been an unusually large number of changes in the personnel of the station staffs. A number of station officers have been called to positions in various branches of this Department; others have been attracted by financial and other considerations to engage in commercial and journalistic enterprises under private management. The expansion of the work of the agricultural colleges, schools, and experiment stations has caused the creation of a considerable number of new positions. There has also been a larger competition among our agricultural institutions to secure the services of thoroughly trained and experienced men, and this has led to a quite general raising of the salaries of agricultural experts. All these causes operating together have led to a widespread shifting of men from one place to another and in the aggregate have seriously affected the quantity and quality of the recent work of our stations. Most agricultural problems require a large amount of serious and continuous work for their solution. The repetition of experiments on a consistent plan during a series of years is often a factor essential to their success. An intimate acquaintance with local conditions of climate, soil, and plant and animal life is in many cases very important to the agricultural investigator. For these and other reasons station officers should

have a permanent tenure of office. In the past it has been necessary to plead for this in order that station officers might be protected against removal for political or other illogical reasons. Happily these irregularities and inconsistencies of station management have now largely been eliminated. But the necessity of securing greater permanence in the personnel of the stations still remains, and this is a matter to which boards of management would do well to give serious attention. In the case of experienced workers who have made a successful record as investigators it is worth while considering the advisability of contracts for periods of say three to five years.

In engaging station officers there should also be more definite agreements regarding the nature and extent of the work to be undertaken, the opportunities for investigation which will be afforded, and the relation of teaching and other duties to the work of research. It can not be expected that the services of first-class investigators can be secured and retained unless they are assured that there will be real opportunities for good work in their line and sufficient funds for the general expenses necessarily attending efficient research. There still needs to be more thorough study of the requirements of research work in agriculture on the part of those charged with the general management of our experiment stations, in order that the grade of their enterprises may be steadily raised and that their work may most efficiently contribute to the success of our vast agricultural interests.

OVERWORKED CONDITION OF STATION OFFICERS.

As the representatives of this Office have visited the experiment stations in different parts of the country during the past year, they have been deeply impressed with the fact that many of our most successful station officers are being overworked. This is chiefly due to the great variety of services which they are called upon to perform. Teaching, lecturing at farmers' institutes and elsewhere, writing books, compiling bulletins and newspaper articles, corresponding with a large number of persons on a great variety of subjects, attending meetings of associations, agricultural fairs, etc., absorb a large amount of time and energy. And when to these things is added the earnest pursuit of new knowledge by night and by day, with perhaps little vacation from year to year, the worker either breaks down prematurely or else, as most frequently happens, the character of his work increasingly approximates the level of mediocrity.

A part of the fault of this unfortunate state of things is undoubtedly to be laid to the charge of the workers themselves. Success in one line often tempts men to broaden their operations to cover lines of effort for which they have no special fitness. An itching for popular applause or the fascinations of administrative functions seduce many

investigators to neglect their laboratories for the office and the lecture platform.

The notion that a man is great according to the multiplicity of his works rather than to their permanent value is widespread among us. The vast and complicated operations of the leaders of our industrial system are too often taken as a model to be followed as far as possible in our educational and scientific institutions.

To have one's ear constantly to the telephone, to dictate rapidly to a stenographer, to be ever on the move in a limited express train—the American scientist seems often to think he is deprived of his rightful privileges if he can not do all these things. To sit down quietly, to plan a thorough investigation of a particular problem, and to pursue the details of that plan month after month until the solution is gained is one of the most difficult things to do amid the feverish activity of our modern world.

Many men attribute their failure to achieve success as investigators to their environment when the trouble is really in themselves. Complaints about lack of time and funds and opportunities count for very little when they come from men who are evidently spreading the scope of their operations beyond a reasonable limit and who can not produce well-conceived and carefully thought out plans of research. When a station worker tells us in one breath that he can not investigate because he is overloaded with teaching and in the next informs us that his spare time is occupied in the private management of a large farm, or that he is on the lookout for an opening as college president, we can hardly be expected to sympathize with him if he proves a failure as an investigator.

But, on the other hand, the failure of our station officers to reach their highest efficiency as investigators must, in very many cases, be attributed to the conditions under which they are compelled to work. Without doubt many advantages have accrued to our stations from their union with colleges, but many evils have also befallen them because of the crude condition of these educational institutions.

Too many of our agricultural colleges are even yet in the high-school stage, and the number of class-room periods required of members of their faculties is reckoned on that basis. This condition is aggravated by the recent popularity of these colleges, which has swelled the number of their students beyond their capacity to accommodate, and has thus materially increased the labors of the teaching staff. When to this is added the success of our experiment stations so that their correspondence and outside calls for their assistance have swelled to vast proportions, and the success of the farmers' institutes and other forms of college extension work among farmers, the demands upon many of our station workers have exceeded their powers of physical and mental endurance.

The splendid liberality of many of our State legislatures toward the agricultural colleges in providing for their equipment with buildings and apparatus is most praiseworthy, but even this has, at least temporarily, laid heavier and most distracting burdens on our station workers. Enlarged material equipment and increased numbers of students are, without doubt, putting heavy burdens upon college presidents and boards of management, who must care for these things and provide teachers for the daily routine of college courses. Their task is a most difficult one and the public needs to have a more intelligent appreciation of its requirements. But it is nevertheless very important that the just claims of the experiment stations to the best services of able investigators should be duly considered and adequately met.

The value of experiment stations as agencies for the improvement of farm practice and as instruments for the enlargement of the science of agriculture, on which the courses in our agricultural schools and colleges are based, is becoming more apparent with each passing year. Theoretically this is more generally acknowledged by the managers of our colleges. But many of them are still urging what they consider valid reasons for refusing to transmute this theory into practice. And our observations of the past year convince us that there has never been a time when it was more necessary to plead on the behalf of our successful station workers that they be relieved from onerous and multifold routine duties, in order that their vigor may be long maintained and their best energies be given to experimental research on behalf of agriculture.

More attention should, in our judgment, be given by the managers of our stations to the hours of labor required of, and the seasons of rest afforded and even enforced upon, our successful station workers. After proper training for research has been acquired, the length of the period during which sustained efforts of the highest order are successfully made is a most important factor in the success of our agricultural investigators. What a waste and loss when the man whose early career gives promise of much fruit of research breaks down in middle life and either dies or lives on in the shadows of mediocrity. Good investigators are exceedingly rare, and it is really the duty of boards of control and college presidents to seek out such men and to guard them carefully against overwork and dissipation of energy.

We plead, therefore, for a broader and deeper study of the human side of our institutions of agricultural research, in order that there may be a richer and more continuous return for the great outlay which our people are making in the hope of benefiting agriculture, and that there may be a greater enriching of the intellectual side of our agricultural colleges, the permanent success of which depends after all very largely on the work of their research departments.

NEED OF INVESTIGATIONS ON A LARGER SCALE.

As the work of the experiment stations develops it is becoming evident that in many lines there is need of experiments on a relatively large scale if thoroughly satisfactory results are to be reached. It is true that some very important results have in the past been obtained by small laboratory experiments and by the use of diminutive field plats. There will always be a useful place in our stations for operations on this small scale, and we would not in any way discourage them. In planning experiments careful consideration should, however, be given to the requirements of the work as related to the expenditures which will be needed to give any hope of useful results. Without doubt much money has been wasted in undertaking experiments on so small a scale as to eliminate all chance of success. But even when relatively small experiments have given indications of new discoveries of practical value there must usually be the repetition of the work on a scale approximating or equaling the conditions of actual practice before safe and permanent deductions should be drawn and published. This is being more clearly recognized, especially as regards field and feeding experiments. It is seen that in most cases field experiments should be conducted during a series of years and in many localities before general conclusions and directions for practical application of results can be safely and authoritatively formulated. Both practical men and station officers are increasingly skeptical regarding the usefulness of feeding experiments in which a small number of animals are used. There are of course reasonable limits as regards the size of experimental fields and the number of animals. Sometimes experimenters have rushed to an opposite extreme and attempted work on a scale too big to be thoroughly covered by their funds and workers. It is far better to make a small experiment thoroughly than to attempt superficial operations on hundreds of acres and with carloads of animals. But we do need larger and more thorough experiments in many lines. In former reports it has been urged that it is unwise for our stations with limited funds to maintain so many different departments that the funds available for the expenses of experiments, other than salaries, are very small. This we would continue to urge, at the same time recognizing that under existing conditions it is practically essential that even stations having only the Hatch fund for their maintenance shall be divided into several departments. It is therefore all the more desirable that in some way additional funds shall be obtained to enable the stations to conduct their operations on a larger scale.

More funds are also required to enable the stations to engage in experimental inquiries in lines which they have hitherto neglected. In the important field of agricultural engineering, with the exception of the work done in irrigation in Colorado, and in a more limited way

in a few other States, the stations have thus far done almost nothing. Though the farmers of the United States are by far the largest users of agricultural machinery in any country, the experiment stations have not undertaken any serious studies of such machinery.

When the Hatch Act was passed, fifteen years ago, it was estimated that the annual value of agricultural products in the United States was three billions of dollars, and that thus the annual expenditures for the stations organized under that act would not amount to more than a tax of 25 cents on every $1,000 of annual agricultural product. The census of 1900 shows that the annual output of farmers now amounts to five billions of dollars. It is believed that the experiment stations have had much to do with our increased agricultural production. The funds expended in their maintenance have thus proved to be highly remunerative investments. Experience has demonstrated that it is a wise policy to invoke the aid of science and expert skill for the extension and improvement of our agriculture.

It would be well therefore for our people to consider carefully the extension of the operations of the stations on a scale which it is believed would secure wider and more permanent results.

NEED OF MORE THOROUGH UTILIZATION OF STATION RESULTS.

Without doubt the results of station work have broadly and definitely affected agricultural practice in this country. There is still, however, great need that our farmers shall take to heart more seriously the advice given by the stations and then make more thorough use of the results of station operations. The practical man often fails to get any advantage from the teachings of the station because he fails to carry out the details necessary to secure the benefits of new methods. A good illustration of this was observed the past summer in one of our States where potatoes are generally grown. The blight appeared early in the season and the station immediately sent out warnings, accompanied by explicit directions for spraying to prevent the spread of the disease. Posters containing all the information necessary for the successful combating of this foe were put up in post-offices, yet only here and there did any farmer pay any attention to the advice of the station. Even men who had spraying outfits, which they had learned to use with advantage in their apple orchards, made no effort to save their potatoes until it was too late. The result was that the potato crop in that State was materially reduced in amount and quality by the ravages of the blight. The difficulty seemed to be that even the more intelligent farmers were not fully impressed with the necessity for prompt and thorough action in preventing such diseases. Their potatoes had grown finely early in the season; it really seemed a pity to put the ill-looking Bordeaux mixture on such fine plants, and so they procrastinated until the blight became firmly established in

their potato fields and it was too late to do anything except to dig the tubers as soon as possible, and thus save a remnant of the promised crop. It is this conservative habit of mind which more than anything else prevents the more rapid advance of our agriculture. Undoubtedly it will require much reiteration of the results of station work, many demonstrations in practice, and much education along new lines to bring the masses of our farmers to appreciate not only the value of station work in general but also the requisites of successful applications of station results on their own farms. It is for this reason that we should have the teaching of the elements of agricultural science and improved agricultural practice in our public schools and farmers' institutes. If we can once change the mental habits of our farmers so that they will respond intelligently, quickly, and thoroughly to the advice of the experiment stations, we shall be able to make these institutions a thousandfold more useful instruments for the advancement of our agriculture. While we should continue to strengthen and extend the work of the stations, we should at the same time make the most strenuous efforts for the more effective practical education of our farmers and their children.

PROGRESS IN AGRICULTURAL EDUCATION.

There has been unusual activity during the past year along all lines of agricultural education. The resources of the agricultural colleges have been materially increased, a considerable number of buildings have been added to their equipment, their faculties have been strengthened, and the number of students pursuing agricultural courses has increased. Specialization along the lines of the science of agriculture, as distinguished from the sciences related to agriculture, has proceeded further than ever before. The greatest advance in this direction has been made in the College of Agriculture of the University of Illinois, where 16 instructors devote their entire time to agricultural subjects. In this college 18 separate courses are offered under the general head of agronomy, 19 under horticulture, 20 under animal husbandry, 13 under dairy husbandry, 2 under thremmatology, and 3 under veterinary science.

The need of graduate instruction in agriculture was definitely recognized in the establishment of a graduate school of agriculture, which held its first session at Columbus, Ohio, during the month of July, 1902. In this enterprise the Ohio State University, the Association of American Agricultural Colleges and Experiment Stations, and the United States Department of Agriculture cooperated. Under these favorable auspices there was little difficulty in securing a strong faculty. As actually organized this included 35 men, of whom 26 are professors in agricultural colleges, 7 are leading officers in the Department of Agriculture, and 2 are officers of the New York State Experiment Station.

Courses were offered in agronomy, zootechny, dairying, and breeding of plants and animals. The school was housed in the substantial and well-equipped agricultural building of the Ohio State University, where were illustrated the most improved apparatus for instruction in soil physics, dairying, and other agricultural subjects. Besides the live stock of the university farm, leading breeders of Ohio furnished choice animals for the stock-judging exercises.

General problems of agricultural science and pedagogy were discussed at the inaugural exercises and at Saturday morning conferences. Among the topics thus treated were the history of agricultural education and research in the United States, the organization of agricultural education in colleges, secondary schools, nature-study courses, correspondence courses, farmers' institutes, and various forms of university extension, what constitutes a science of agriculture, methods and values of cooperative experiments. Through social assemblies, visits to typical Ohio farms, and much informal discussion wherever the students met each other, the educational influences of the school were greatly extended. Seventy-five students were in attendance. These were drawn from twenty-eight States and Territories, including such widely separated regions as Maine, Oregon, California, New Mexico, and Alabama. There was one student from Canada and one from Argentina. There was also one woman, and the colored race was represented by teachers from the Tuskegee Institute and the agricultural college at Greensboro, N. C. Twenty-seven of the students are professors or assistant professors of agriculture in agricultural colleges, 31 are assistants in the agricultural colleges and experiment stations, 9 are recent college graduates, and 8 are engaged in farming. Without doubt, the influence of this school will be felt throughout the country in the improvement of courses of instruction in agriculture and the strengthening of the lines and methods of investigation of agricultural subjects. It will also serve to stimulate greatly the movement already begun for the reduction of the materials of agricultural science to "pedagogic form" for use in colleges and secondary schools, and for the reorganization of agricultural institutions of research on the basis of the divisions and subdivisions of agriculture instead of physics, chemistry, botany, and other primary and secondary sciences.

The movement for the establishment of secondary courses and schools of agriculture has also made considerable progress during the past year. The assured success of the agricultural high schools organized in connection with the colleges of agriculture of the Universities of Minnesota and Nebraska has led to other efforts in this direction. Two county agricultural high schools, established under a recently enacted State law, have opened their doors to students in Wisconsin. The Association of American Agricultural Colleges and Experiment

Stations has undertaken to aid this movement through its standing committee on methods of teaching agriculture, which presented a report to the convention held at Atlanta, Ga., in October, 1902, outlining tentative high school courses of which agricultural subjects formed a part It was thus attempted to show that agriculture might be introduced in our public high schools without any radical reorganization of existing courses.

The introduction of agricultural subjects into the schedules of nature study, now so widely adopted in the elementary schools throughout the country, is progressing rapidly, and there is much interest in the establishment of school gardens in connection with such study. This Department is helping in this work by the distribution of seeds and by giving advice and assistance to school managers and teachers. There is also a widespread movement for the general improvement of the rural schools by the consolidation of schools, the free transportation of pupils, the employment of efficient teachers, and the betterment of school buildings, equipment, and grounds.

Not only are communities and public officers aroused to new zeal and enthusiasm in the cause of public education, but private philanthropists are making unusual efforts to promote this cause. Two general boards, having behind them men of large wealth, have been organized to stimulate the formation of right public sentiment on this great question by the establishment of model schools in destitute communities and by grants of money to secure more thorough training of teachers. And it is very encouraging to observe that these boards are already giving much attention to the problems of agricultural education.

THE FARMERS' INSTITUTES.

During the past year over 2,700 farmers' institutes were held in forty-three States and Territories. The total attendance at these institutes during the year was approximately 810,000 persons. About $163,000 was expended by the States in conducting the institutes, in addition to the expenses incurred by the local authorities, which in some States amount to several thousand dollars per annum. In more than half the States and Territories no regular provision for the maintenance of institutes is as yet made, and in only eight States is more than $5,000 annually appropriated for this purpose. The agricultural colleges and experiment stations continue to do a large amount of work in connection with the institutes. This work is important and useful, but in so far as it is a drain upon the resources of these institutions and a diversion of the energies of their officers from their regular duties in agricultural education and research, it constitutes an unfortunate element in the present status of the American system of agricultural education and research. The farmers' institutes should receive more liberal support from the States and Territories, and a corps of

special workers should be organized to conduct them. The teachers and investigators of the agricultural colleges and experiment stations should only be employed incidentally to lecture at institutes and should not give any considerable portion of their time to this service. In general, the farmers' institute movement in this country needs more thorough organization and should be extended so as to reach in some effective way the great mass of workers on our farms.

To promote the general interests of the farmers' institute movement in the United States and Canada, the American Association of Farmers' Institute Workers was formed several years ago. Its seventh annual convention was held at Washington, D. C., in June, 1902, and was attended by delegates from twenty States and the Dominion of Canada. The proceedings of this convention have been published as a bulletin of this Office. An account of this association is given on page 51.

Efforts are being continued by this Office to aid the farmers' institutes in the different States and Territories, and it is hoped that during the coming year this part of the business of the Office will be put on a more permanent and effective basis.

A brief account of the status of the farmers' institutes in the several States and Territories is given on page 461.

THE ASSOCIATION OF COLLEGES AND STATIONS.

The Association of American Agricultural Colleges and Experiment Stations held its sixteenth annual convention at Atlanta, Ga., October 7–9, 1902. This meeting was well attended, and there was much interesting discussion of the problems of agricultural education and research. It was decided that an earnest effort should be made to secure funds for an exhibit at the Louisiana Purchase Exposition to be held in St. Louis in 1904 demonstrating the substantial progress made by the land-grant colleges in recent years, especially in the various branches of agriculture and mechanic arts. Amendments to the constitution of the association were proposed, which, if adopted by the next convention, will make the meetings more fully than heretofore places for the discussion of the larger questions relating to the organization and administration of the educational and research institutions comprising the membership of the association. A brief account of the Atlanta meeting is given on page 45.

THE OFFICE OF EXPERIMENT STATIONS.

The functions of the Office of Experiment Stations have been enlarged in several directions during the past year, and the enterprises previously in its charge have become more extensive. Especial efforts have been made to aid the movement for the strengthening of agricultural education and research through the more definite formu-

lation of agricultural science and the more thorough training of agricultural experts. For this purpose the work of this Office, in connection with the Graduate School of Agriculture as described elsewhere in this report, has proved to be unusually successful and effective. Attempts have also been made to call the attention of the agricultural public and the managers of educational systems to the great desirability of making agricultural subjects a part of the curriculum of secondary and elementary schools. The development of the farmers' institutes as effective agencies for the dissemination of the results of the work of this Department and the experiment stations has also received attention. The agricultural experiment stations under the direct management of this Office in Alaska, Hawaii, and Porto Rico have been put upon a firm basis, and much progress has been made in developing useful lines of work in these regions.

The Office has been brought into closer relations with the institutions for agricultural research in foreign countries through work involved in the preparation of a bulletin setting forth the organization, resources, and lines of work of these institutions. By this means our knowledge of these foreign institutions has been greatly broadened, and it will be more feasible hereafter to secure definite information regarding their work which will be useful to similar institutions in this country. Both the legal and engineering features of the irrigation investigations have been enlarged, and a beginning has been made of investigations in other lines of agricultural engineering which have hitherto been neglected by this Department. Improvements have been made in the apparatus and methods for nutrition investigations. The results of these investigations have been more effectively brought to the attention of teachers of physiology and domestic science, and beginnings have been made of what it is hoped may develop a systematic study of dietaries in public institutions.

With the expansion of its work the amount of useful material prepared for publication in this Office has materially increased. Special efforts have been made during the past year to publish this material in forms which will contribute to its effective and economical distribution.

A brief account of the general business of the Office will be found on page 54, and details of its operations are given in other portions of this report.

EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

Progress has been made during the past year in the development of agricultural investigations in Alaska, Hawaii, and Porto Rico, under the direct management of this Office. In addition to the stations hitherto maintained at Sitka and Kenai, in Alaska, beginnings have been made of regular experimental work at Rampart, in the Yukon

Valley, and at Copper Center, in the Copper River region. There are increased evidences that the work of the Alaska stations is stimulating the residents of that Territory to enlarged efforts to develop agriculture in different regions and that the distribution of varieties of seeds better adapted to Alaskan conditions is already producing valuable results not only in increased yields of produce, but also in the encouragement it gives to intelligent attemps at agriculture in that region. Further study of the conditions relating to animal industry in that Territory has shown that there is good reason to expect that Alaska will eventually maintain large numbers of live stock. It is hoped that the stations will before long be given sufficient financial support to enable them to prosecute experimental inquiries along this line on a sufficient scale to reach convincing results.

In Hawaii the station at Honolulu has been sufficiently equipped to enable it to institute systematic inquiries in a number of useful lines and to begin the publication of bulletins. Considerable study has also been made of the local agricultural conditions in different islands, and a system of farmers' institutes has been inaugurated under the auspices of the station.

In Porto Rico the liberality of the insular government and the municipality of Mayaguez has enabled the station to purchase a farm of 235 acres, and thus to secure a permanent location at Mayaguez. Plans are therefore being made for the systematic conduct of experiments there, which it is hoped will ere long be productive of valuable results. At the same time cooperative experiments in coffee culture and in other lines will be undertaken in different localities as far as the means of the station will permit. Important studies of the mole-cricket, known as the changa, which is injurious to many crops in the island, have been made, and the results thus far obtained have been embodied in a bulletin which has been issued in both English and Spanish.

In order that the stations directly controlled by this Department may be well-manned and equipped and may conduct thorough experiments in the same way that stations organized under the Hatch Act are expected to do, they must have adequate financial support. There is every reason why the National Government should do as much for these stations as for those in other parts of the United States, and the local governments and communities should continue to aid them as far as they can, as is done elsewhere throughout the country.

A further account of the stations in Alaska, Hawaii, and Porto Rico may be found on pages 71, 91, and 163, respectively, and the detailed reports of the special agents in charge may be found on pages 233, 309, and 331, respectively.

NUTRITION INVESTIGATIONS.

The nutrition investigations have been continued along the same lines as heretofore, including dietary studies, and digestion, cooking, and metabolism experiments. These studies have been carried on in cooperation with universities and experiment stations in Maine, Massachusetts, Connecticut, New York, Tennessee, Illinois, California, Minnesota, Vermont, and Georgia. The respiration calorimeter used in these investigations has been improved, and the studies during the past year with this apparatus have had reference especially to the relative efficiency of fats and carbohydrates as sources of energy for the performance of muscular work. To further study the relation of diet to muscular work, dietary studies with lumbermen performing severe work in the forests of Maine have been made. Among other subjects of investigation have been the digestibility and nutritive value of bread made from different kinds of flour; the effect of cooking on the nutritive value and digestibility of different kinds and cuts of meat; the relative nutritive value of different kinds and combinations of fruits and nuts, and the comparative metabolism of nitrogen, sulphur, and phosphorus. Five bulletins regarding the results of nutrition investigations were published during the past year. Special efforts have been continued to bring the results of this work to the attention of schools and colleges, physicians, scientists, superintendents of public institutions, persons engaged in philanthropic enterprises, etc.

At the summer school of nutrition and bacteriology, held at Wesleyan University, Middletown, Conn., in July, 1902, under the direction of the special agent in charge of nutrition investigations in connection with his work as professor in that institution, the methods and results of the nutrition investigations of this Department were explained to a considerable number of teachers of domestic science from different regions, and others who have engaged to a greater or less extent in the teaching of nutrition, bacteriology, and kindred subjects in the agricultural colleges and other institutions.

As stated in last year's report, it is very desirable to extend the nutrition investigations through a systematic study of dietaries in public institutions. Plans for beginning this work have already been made, and considerable material, including summaries of results of early investigations, has been collected. Through an arrangement with Dr. A. B. Richardson, superintendent of the Government Hospital for the Insane in the District of Columbia, dietary studies are being made in that institution during the current year in accordance with plans furnished by this Office.

An article giving a brief account of investigations thus far made regarding the feeding of groups of men, especially in public institutions, and setting forth some of the beneficial results which have come from such studies, may be found on page 387.

IRRIGATION INVESTIGATIONS.

During the past year the irrigation investigations of this Office embraced the following lines of work:

(1) Measurements of the volume of water used and studies of the most efficient methods of applying water to crops in all of the arid States but one. Similar measurements in the rice districts in Louisiana and Texas and in four of the humid States of the Mississippi Valley and Atlantic seaboard.

(2) Measurements of the losses of water from canals by seepage and studies of the best means of preventing the destructive rise of the water coming from these canals in the cultivated lands below. These measurements have shown that drainage has a greater importance than has hitherto been realized, and that irrigation in all of the larger cultivated districts must be supplemented by drainage. In sections where frost has not to be contended with, canals can be cemented and these losses prevented in this way, but in the greater part of the arid region the water which wastes from the canals must either be intercepted by deep drainage ditches and carried away to points where it can be applied to arid areas, or returned to the stream by means of a system of open or tile drains. Studies of the drainage problems were carried on in Colorado, California, and a beginning made in Washington.

(3) The studies of the legal and economic questions connected with the appropriation of streams by irrigators were continued by studies of the water-right situation on Carson and Walker rivers in Nevada, Sevier and Virgin rivers in Utah, and the Gallatin River in Montana, and a study of the interstate water-right questions on the Platte River, embracing the rights of appropriators and riparian proprietors, has been begun. The need of some final and definite settlement of the nature of water ownership which shall be recognized and some simple and effective means of establishing the rights of existing users is becoming every year more urgent. Until this has been settled, there can be no safe or enduring foundation for future development.

(4) The past year has witnessed a considerable extension of irrigation in the humid portions of the United States, and tends to confirm the belief heretofore expressed that this aid to agriculture is destined to have a large field of usefulness in the East as well as in the West. The rapid growth of rice irrigation along the Gulf coast has been continued, and it has been supplemented in other parts of the South by the installation of pumping machinery for the irrigation of market gardens, and, in some instances, of comparatively large areas of field crops. All of the reports thus far received from these experimental efforts in the South have shown that irrigation is profitable. In the northern and eastern part of the United States the results for the past season were not so conclusive because of the exceptionally large rainfall of last summer, but reports from Wisconsin and New Jersey are

to the effect that, even in this season of ample rainfall, the lands which were irrigated showed an increase over the unirrigated areas.

The results of the irrigation investigations of this Office may be summarized as follows:

(1) The measurements of water used in irrigation have shown:

(*a*) That the losses from canals by seepage are much greater than have generally been supposed, amounting in some instances to one-half of the volume diverted.

(*b*) This escaping water lessens the effective service of the stream, saturates large areas, rendering them unfit for cultivation through excess of water, excess of alkali, or both.

(*c*) The average volume of water used in irrigating an acre of land under present practice is greater than has been assumed by the majority of writers on the subject and less than has been granted in many adjudications of water rights.

(*d*) The determination of an approximate standard for the duty of water in every important irrigation district is as necessary to the just establishment of titles to water, or the effective division of streams among users, as the establishment of a unit of value in trade or commerce.

(*e*) The need of increased knowledge of the duty of water has been made more urgent by the passage of the national irrigation act, under which the area of land which a given water supply will irrigate has to be determined in advance of its actual use in apportioning the cost of the work and determining whether these projects can be made to pay.

(*f*) To provide for the distribution of water among a multitude of users and lay the foundation for future development, these studies of the duty of water should be continued until the approximate volume required in each district where they are made has been ascertained. They should be extended to other important irrigated districts of the arid region until all the varying conditions of soil, climate, and crop have been dealt with.

(2) The conservation of the water supply and the area of land which it will irrigate will be largely determined by the economy and skill with which it is used by irrigators. These investigations have shown that much can be done by lessening the loss from seepage in canals, by draining the areas which have been rendered unfit for cultivation by the rise of seepage waters, and applying the water carried off by these drains to the reclamation of lands now arid. The improvement of canals and the preparation of plans for the drainage of irrigated areas involve new and complex engineering questions, which require expert study in their solution. The demand for information with respect to these matters and the important results already secured lead to the belief that the studies of the problems of soil water connected with seepage and drainage are among the most important questions committed to this investigation.

(3) The studies of the legal and economic problems of irrigation have shown:

(*a*) That under the lax and imperfect irrigation laws of some of the Western States great uncertainty exists with respect to titles to water, and litigation and controversy have resulted which have been an obstacle to development and exceedingly expensive and annoying to water users.

(*b*) Under these laws claims to water have been recorded which amount in the aggregate to many times the volume now in use, and on some streams to far more than the total supply. Owing to lack of information of the actual volume of water required to irrigate an acre of land, many rights have been decreed in excess of actual necessities. The question therefore arises: Are the present rights to water limited to the actual present uses or do these excessive decrees constitute a valid title to the stream? In some cases their holders have sought to put them to profitable use by selling the surplus. Doing this makes of the water of a stream a private, speculative property.

(*c*) The larger use of water by cities and towns for manufacturing, the increasing area of land being brought under irrigation, and the larger number of people depending on streams for the value of their homes and the return for their labors render it indispensable that some simple, conclusive method of establishing titles to water for all purposes should be established, and that the rights so established should be protected in times of scarcity. The vital importance of this question to the whole country, and the need of guarding against selfishness and greed acquiring unjust rights to this important resource, render it indispensable that streams should be placed under public control, and that no less authority than the public should determine the actual needs of users and supervise the establishment of their rights.

(*d*) The respective spheres of State and National authority over both State and interstate water supplies should be more clearly defined than they are at present, in order that effective legislation for the establishment of titles and protection of rights may be had.

A more detailed account of the irrigation investigations may be found on page 359.

FOREIGN EXPERIMENT STATIONS.

The work of preparing the card catalogue of foreign agricultural institutions for education and research has been continued, and an account of the organization, equipment, expenditures, and work of foreign experiment stations has been published as Bulletin 112 of this Office. The bulletin contains brief accounts of about 720 experiment stations and similar institutions arranged in alphabetical order by countries and cities. This number includes, however, many institutions which, for lack of further information, are mentioned in the bul-

letin by title only, and a quite large number of experimental fields, laboratories, and enterprises which in this country would not be called stations.

The list demonstrates the world-wide extent of the station movement at the present time, embracing nearly all the civilized countries of the globe. The most notable exception in Europe is Greece, where so far as can be learned there are no stations or similar agencies in operation. In Asia there are a goodly number of stations, located in Russia, Japan, and British India. The Chinese Empire represents a large area which is entirely without stations, and the same condition applies to Turkey, Persia, Afghanistan, and Beloochistan. Africa has quite a large number of stations in the English, French, and German colonies. There are no stations as yet in Mexico or in Central America except in British Honduras, where a botanic garden is located; and in the South American countries no trace has been obtained of any stations in Bolivia, Colombia, Ecuador, Patagonia, Peru, Uruguay, or Venezuela. Australia and New Zealand have a large number of stations of various kinds which are actively studying the practical problems suggested by the agriculture of these countries.

The largest number of separate agencies for investigation and experimentation in agriculture is found in Russia, where there are 102 such establishments and 3 experimental forests. Many of them are small demonstration fields established for the purpose of instructing the peasants or of introducing new agricultural industries. Others serve as the centers for the production of improved varieties of seeds and plants, and some are conducted as institutions for research. The number of German stations listed is 80, which includes about one dozen control stations and laboratories for miscellaneous analyses, together with a number of stations for special industries. France has 71 agricultural stations and laboratories, and Austria 41 stations, about one-third of which are of the grade of the control station. In the British islands there are about 30 agencies, including 12 institutions that may be regarded as stations, 10 institutions which are subsidized by the board of agriculture, and 7 botanic gardens. The British possessions in India contain 10 experiment farms and plantations and 21 botanic and municipal gardens, besides a number of other agencies for the benefit of agriculture. Belgium has 15 stations, 7 of which are analytical laboratories.

A feature of the system in Australia, which includes 34 institutions, is the State farms, of which there are 15 scattered over the country. In the Netherlands there are 7 stations and a system of experimental fields, 11 in number, conducted under the auspices of local agricultural and horticultural societies, but subsidized by the Government. Sweden has 26 stations, most of which are chemical and seed-control stations; Japan, 15, including 9 branch stations; Switzerland, 10, and Spain, 4.

These comprise the principal countries in which experiment stations and similar agencies are most active, with the exception of Canada and the United States. The full list, however, includes Algeria, Argentina, Bosnia and Herzegovina, Bulgaria, Brazil, Egypt, Java, Portugal, Roumania, and many minor countries and dependencies.

One of the most important recent events, from an agricultural point of view, is the establishment of the department of agricultural and technical instruction in Ireland. This department was organized for the purpose of aiding, improving, and developing agriculture, fisheries, and other industries in Ireland in such a manner as to stimulate and strengthen the self-reliance of the people, and is associated with four advisory and cooperating boards or committees. It has an endowment of over $800,000, besides funds for maintaining a number of institutions turned over to it. The distinctive agricultural features already inaugurated are along the lines of agricultural instruction, the improvement of live stock, and agricultural experiments and investigation.

In France an office of agricultural information has been established under the ministry of agriculture. It takes the place of the former bureau of agricultural statistics and food products, and will publish statistical information in regard to agriculture, agricultural labor, products and conditions, imports, public sales, etc., in France and in foreign countries.

Among the experiment stations recently established are the seed-control station for forest seeds, in connection with the royal Prussian forestry academy at Eberswalde; the agricultural experiment station at Augustenberg, formed by the union of the chemical and botanical stations formerly located at Karlsruhe; a dairy station in connection with the agricultural institute at Gembloux, Belgium; and an agricultural physiological experiment station in connection with the technical high school at Prague, Austria.

Another notable event of the year was the celebration of the fiftieth anniversary of the establishment of the royal agricultural experiment station at Möckern. This being the oldest station of its kind in the world, the occasion was one for general congratulation and is of especial interest to all friends of the experiment-station movement. Prof. Oscar Kellner, the present director of the station, had prepared a Festschrift, or historical address, which was printed in advance, reviewing the incidents in the establishment of the station, its gradual development and present status, and summarizing its principal lines of work.

THE ASSOCIATION OF AMERICAN AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

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SIXTEENTH ANNUAL CONVENTION.

The Association of American Agricultural Colleges and Experiment Stations held its sixteenth annual convention in Atlanta, Ga., October 7 to 9, 1902. President W. M. Liggett, of the University of Minnesota, presided at the general sessions and delivered the annual presidential address. This discussed briefly the important agencies for the promotion of instruction and research in agriculture. While recognizing the varying needs of different sections of the country as to ways and means for accomplishing the best results, the speaker emphasized the fact that in discussions of this kind geographical lines must be wiped out and a free interchange of ideas be encouraged. Efficiency and ability to do were set as the goal to be attained in any system of education, and these are attained quite generally in agricultural education. A review was given of the progress made in various lines of industrial education, including that of the agricultural colleges and experiment stations, agricultural high schools, short courses, farmers' institutes, and the Graduate School of Agriculture at Columbus. The speaker also emphasized the importance of giving attention to elementary instruction in agriculture in the rural schools. The need of adjusting the relation of instruction to research was pointed out, and two institutions were mentioned as important agencies in this

connection—the Graduate School of Agriculture, to train teachers and investigators, and the Carnegie Institution, to provide for and aid research, to furnish conditions necessary for the development of science.

Dr. Daniel Morris, commissioner of agriculture, imperial department of agriculture of the British West Indies, and William Fawcett, director of the department of public gardens and plantations, Kingston, Jamaica, attended the sessions of the convention, and upon invitation from the association, Dr. Morris made a short address, in which he thanked the association for courtesies shown him and his colleague and expressed a desire on the part of the imperial department of agriculture of the British West Indies to cooperate with the United States Department of Agriculture in promoting agricultural education and research in the West Indian possessions of the United States. An address on Education at Tuskegee was presented in a general session by G. W. Carver, director of the agricultural department of the Tuskegee Normal and Industrial Institute.

The report of the executive committee, presented by its chairman, H. H. Goodell, recommended (1) renewed efforts for the establishment of colleges of mining; (2) revision of Circular 34 of the Office of Experiment Stations, Rules and Apparatus for Seed Testing; (3) that the association instruct its executive committee, or appoint a special committee, to communicate with the War Department and request some modification of its recent order increasing the amount of military instruction in the land-grant colleges, and (4) that the Graduate School of Agriculture be continued, the association to assume the necessary expense of maintenance, less such amount as may be voluntarily contributed by the institution at which the school is from time to time held, this expense to be met by assessments upon the colleges and universities represented in the association in proportion to the income of these institutions.

The report of the bibliographer, A. C. True, noted especially the marked increase in the number of publications reviewing literature along general lines, such as chemistry, plant protection, and veterinary medicine, and called attention to the number (over 100) of partial bibliographies and reference lists along lines related to agriculture. Mention was also made of the beginning made in the preparation of an international catalogue of scientific literature in 17 branches of science.

A report on the Graduate School of Agriculture, at Columbus, was given by A. C. True, dean of the school. The school opened July 7 and continued four weeks, closing August 1. The faculty included 35 men, drawn from agricultural colleges, this Department, and the New York State Station. Seventy-five students were in attendance. These were drawn from 28 States and Territories, from Canada, and from

Argentina. Twenty-seven of the students are professors or assistant professors of agriculture in agricultural colleges, 31 are assistants in the agricultural colleges and experiment stations, 9 are recent college graduates, and 8 are engaged in farming. The expense of the school was $3,945.12. The income from fees was $450, leaving a net cost of $3,495.12, which was borne by the Ohio State University.

The report of the committee on indexing agricultural literature, presented by A. C. True, chairman of the committee, included a statement regarding the work along this line accomplished by the Department of Agriculture during the year, including the card index of experiment station literature published by this Office, and card indexes of Department publications prepared by the librarian of the Department. Attention was called to the increasing amount of indexing necessary to keep up with Department publications and to the lack of sufficient funds for accomplishing this work. It was stated that the Librarian of Congress would cooperate to the extent of printing index cards from this Department as a part of the index issued by the Library of Congress. In order to prepare the copy for these cards, additional help is needed in the Department library, and the committee recommended that the executive committee of the association make an effort to secure from Congress an appropriation of $2,500 to carry on the work.

A lively discussion was precipitated by the reports of the two committees appointed to consider the matter of making exhibits from the land-grant colleges at the St. Louis Exposition. Both the committee on collective station exhibit and the committee on cooperative college exhibit (mechanic arts) favored making exhibits at St. Louis, but the latter committee reported in favor of a combined effort to project a comprehensive exhibit of the entire work of the colleges and stations. The association voted in favor of a unified exhibit of the distinctive features of college and station work, to be in charge of one committee consisting of the members of the two committees already appointed, and asked the executive committee to make an effort to secure from Congress an appropriation of $60,000 for installing and maintaining the exhibit.

The committee on graduate study at Washington reported very limited progress, owing to complications arising from the establishment of the Carnegie Institution. No effort had been made to secure opportunities for graduate study in any of the Departments except the Department of Agriculture, which has made more general use than formerly of the register for scientific aids.

The report of the committee on methods of teaching agriculture was presented by A. C. True. The report included a brief account of the Graduate School of Agriculture, at Columbus, a statement that a report on facilities for teaching agronomy would soon be published, and an account of work undertaken by the committee for the promo-

tion of secondary agricultural education. The demand for secondary agricultural education and the inability of existing institutions to fully meet that demand were pointed out. The committee therefore undertook to show how, with very little rearrangement, courses of study in the public high schools could be adapted to the needs of the pupils desiring instruction in agriculture. This report has been issued as a circular of this Office.

A resolution introduced by E. Davenport, and adopted by the association, indorsed the plans of the Secretary of Agriculture for the promotion of farmers' institutes throughout the country and pledged the active cooperation of the association in efforts to secure adequate financial support for this enterprise. A resolution calling on the executive committee to use its influence with Congress to secure the regular and prompt publication of the Annual Report of the Office of Experiment Stations was introduced by H. J. Wheeler and adopted by the association.

W. H. Jordan introduced a resolution, which was adopted, urging upon the trustees of Carnegie Institution the importance of agricultural science to the national welfare and expressing the hope that the magnificent gift of Hon. Andrew Carnegie may be used in some measure to promote investigations touching the relations of the sciences to agriculture.

A resolution, introduced by E. Davenport and adopted by the association, provided that the executive committee urge upon Congress that it increase the appropriation for each agricultural experiment station by the sum of $15,000 annually if, in the opinion of the committee, such action would be expedient.

Amendments to the constitution, introduced by W. A. Henry, provide for doing away with the present sections of the association and dividing it into two sections—one on college work and administration, the other on experiment station work. The amendments further provide that no action on public and administrative questions shall be final without the assent of the section on college work and administration. These amendments will be acted on at the next convention.

In the section on agriculture and chemistry, a leading place was given to the discussion of some beef problems of the South, and what the stations can do toward solving them. Papers on various phases of the problems were given by A. M. Soule, C. W. Burkett, D. W. May, and J. C. Robert. The investigation of feeding problems was discussed by H. P. Armsby and C. F. Curtiss, the former presenting the practical value of respiration calorimeter experiments, and the latter the scientific value of feeding experiments on a large scale. The possibilities in plant breeding and the sources of carbohydrates for the South were the other topics discussed in this section.

The report of the section on horticulture and botany, presented by the chairman, John Craig, gave the results of an inquiry regarding the trend of efforts on the part of teachers and investigators in horticulture and botany. It showed the tendency in horticultural teaching to be toward an increase of laboratory and field work; in horticultural investigation, toward an increase of cooperative work. Teachers of botany, he found, were making progress toward more clearly differentiating the different branches of the study. The majority of them considered physiological botany of greater relative importance than systematic botany. Investigators in botany are of the opinion that cooperation between botanists is feasible, but are doubtful whether the same is true between botanists and farmers. In the section meeting on horticulture and botany the problem of providing better courses of instruction in botany was given considerable prominence. A. D. Selby regretted that there is no provision in the curricula of agricultural colleges for teaching vegetable pathology and that little attention is given to vegetable physiology. E. M. Wilcox, speaking on the same subject, gave statistics showing lack of courses in plant pathology and physiology in about 120 educational institutions in this country. A paper by L. H. Bailey on The Editing of Experiment Station Publications was read by the secretary. The other subjects considered in this section were: Lines of experimentation invitingly open to station botanists; plant breeding to secure resistant forms; some peculiar needs in new States; variety tests in Florida; bulletin illustration; how far should the experiment be followed by eduational effort on the part of the experimenter.

In the section on college work A. C. True presented a paper on the Graduate School of Agriculture as a Means of Improving the Pedagogical Forms of Courses in Agriculture, in which, after pointing out the lack of pedagogical form in agricultural courses as now taught, he showed how the Graduate School of Agriculture might be expected to result in gradually improving these conditions, how it might result in better agreement among educators regarding topics to be taught and the order of treatment, how the apparatus found at Columbus had furnished many suggestions for improving the apparatus in other institutions, and how a movement had already been started to put into printed form some of the lectures delivered at this school. He noted as an encouraging indication the organization of agricultural faculties with special teachers for different divisions of the subject of agriculture, instead of, as formerly, a number of teachers presenting the sciences related to agriculture. The paper was discussed by T. F. Hunt, who considered it as important to prepare for the profession of teaching in agriculture as to prepare for executive duties or research work, and by J. F. Duggar, who had received at the Graduate School of Agri-

culture many valuable suggestions for methods of instruction and for making apparatus. A paper on Agricultural Education in the South, presented by J. C. Hardy, gave an interesting review of educational conditions in that section prior to the organization of agricultural colleges and of the subsequent stimulation of educational interests as a result of the organization of those colleges. J. W. Heston presented a paper on Military Instruction in Land-Grant Colleges.

In the section on entomology three subjects of general interest were discussed. Excellencies and defects of existing legislation for the control of insect and fungus pests was discussed by S. A. Forbes and others, including a number of the members of the American Horticultural Inspectors' Association. J. B. Smith discussed recent observations and experiments with insecticides for the San José scale, and H. T. Fernald cooperation in making insecticide tests.

The section on mechanic arts discussed a number of subjects closely related to problems of interest in the South. W. M. Riggs gave a paper on conducting engineering and laboratory work, in which he described methods as they now exist and emphasized the importance of giving more time to laboratory work. The power question in the South was discussed by C. M. Strahan and sugar engineering by T. W. Atkinson, the latter describing the course of study as it is arranged at the Louisiana State University.

THE AMERICAN ASSOCIATION OF FARMERS' INSTITUTE WORKERS.

OFFICERS.

President,
W. C. Latta, of Indiana.

Vice-President,
J. G. Lee, of Louisiana.

Secretary-Treasurer,
G. C. Creelman, of Ontario.

Executive Committee,
The President and the Secretary-Treasurer, *ex officio.*
S. L. Patterson, of North Carolina. A. B. Hostetter, of Illinois.
A. L. Martin, of Pennsylvania.

SEVENTH ANNUAL MEETING.

The seventh annual meeting of the American Association of Farmers' Institute Workers was held in Washington, D. C., June 24–26, 1902. About 60 members were present, including representatives from Canada and nearly all parts of the United States. Assistant Secretary J. H. Brigham, of the United States Department of Agriculture, delivered the address of welcome.

The annual address of the president of the association, W. L. Amoss, dealt with the purposes of the convention, the improvement and possible unification of methods, and the general progress of farmers' institute work. Following his address five-minute reports by the different members were presented, showing the work of the various States and provinces during the preceding year along farmers' institute lines.

During one of the evening sessions of the association Secretary Wilson delivered an address on the work of the United States Department of Agriculture and its relation to agricultural education, calling especial attention to the lack of scientists and teachers trained along agricultural lines and to the need of providing better facilities for such training. He insisted that agricultural education must begin with the child and commended the plan observed in Missouri of summer meetings in which many teachers were given instruction in agriculture at the college.

W. J. Spillman spoke on the farmers' institute worker and his methods. One of the essentials of an institute worker is that he be practical. It is not necessary, however, that he be a worker on the farm. The best man to send out in the beginning is a scientific man who is practical. Ability is worth more than experience. In the discussion of this subject George McKerrow stated that in Wisconsin they wanted a man that stood high morally in the community and who stood out prominently as the best corn, potato, or clover grower, or the best breeder, dairyman, or all-around farmer. Wisconsin also required that its institute workers keep in close touch with the work of the experiment stations and of this Department. Extensive use is made in that State of charts showing good forms of farm animals, buildings, and appliances, and models of these when possible. More can be taught in a few minutes from an object lesson than from a long talk. Feeding and fertilizer charts are also used. Prizes are offered at many of the institutes for certain farm products, and these are judged and criticised in the presence of the audience. Hon. John Hamilton stated that in Pennsylvania their ideal corps of institute workers consisted of (1) a good all-around scientific and practical man (2) a man who thoroughly understood the scientific side of agriculture, and (3) a successful practical farmer of high moral standing actually engaged in farming.

In presenting the subject of the farmers' institute as a factor in creating a desire for an agricultural education, Hon. John Hamilton stated that the need of such instruction must first be felt. Farmers' institutes can help in creating this desire by securing institute workers who are superior to the audience in the things they discuss. They must then present superior matter in a way to carry conviction. It was urged that abstracts of the latest bulletins should be read at farmers' institutes and farmers encouraged to secure for these publications. A large part of the educational work of the farmers' institutes should be directed to the improvement of the country schools. The great need of the present is to create a desire in the child for agricultural education.

Dr. E. B. Voorhees discussed the farmers' institute as a promoter of closer intimacy between farmers and experiment stations. He brought out the point that station work must be practical in order to inspire confidence in the farmer; it must be educational as well as investigational. Larger plats must be used—large enough to grow what might properly be called a crop. Station workers also often get ideas at farmers' institutes as to lines of work to follow.

Dr. A. C. True discussed the subject of the farmers' institute as a medium for developing the mutual interests and relations of farmers and the United States Department of Agriculture. He urged the necessity of a permanent organization in this Department, whose

purpose should be to secure a more thorough organization of the farmers' institutes in the States and Territories and of the present Association of Farmers' Institute Workers, so that it might become in a real and true sense international and constitute a link between the Department and the farmers. Such an organization would act as a clearing house for the association. As it now is only one meeting is held each year. An agency is needed in the Department to work all the time. Such an agency would be a cooperating one. It would collect and publish information along farmers' institute lines, both in this country and abroad, furnish institute workers regularly with literature, advise and assist institute workers by reason of its broader outlook, and endeavor to establish the work in States where it is not now carried on. Such an organization could send out lecturers to the round-up institutes. Work along the lines here indicated has already been begun in a small way and is now being supervised by the Office of Experiment Stations.

The subject of agricultural teaching in the public schools was discussed by Prof. C. C. James and Dr. E. B. Voorhees. Instruction along agricultural lines should be given teachers in the normal school. This teaching should deal with the science and not the practice of agriculture. The normal school will train teachers in agriculture just as soon as there is a demand for such teachers. Farmers and farmers' organizations should therefore create this demand and then see that agriculture is placed on the programme of the rural school.

Other papers read and discussed at the meeting were: Teaching Domestic Science in the Rural Districts, by Miss Evelyn Breed, of Norfolk, Va., and Miss Emma S. Jacobs, of Washington, D. C.; The Relation of Railroads to Agriculture, by M. V. Richards; and The Judging of Live Stock as Farmers' Institute Work, by G. C. Creelman. A paper on Agriculture in Rural Schools, by E. P. Powell, of New York, was read by title and printed in the proceedings.

At the business session of the meeting Toronto, Ontario, was selected as the next place of meeting. An amendment to the constitution granting to the United States Department of Agriculture and the Office of Experiment Stations representation in the association was proposed, and the following resolution was adopted:

Resolved, That the American Association of Farmers' Institute Workers cordially and most heartily approves the action that has been initiated by the Secretary of Agriculture in the matter of closer communication between the Department and the farmers' institutes, with the hope that an agent will be appointed, as suggested in Dr. True's paper.

An account of the farmers' institutes in the United States is given on page 461.

OFFICE OF EXPERIMENT STATIONS.

An office in the United States Department of Agriculture.

GENERAL OUTLOOK.

The functions of the Office of Experiment Stations have been enlarged in several directions during the past year, and the enterprises previously in its charge have become more extensive. The advice and assistance of this Office in many matters relating to the organization, equipment, and work of the experiment stations continue to be sought in a large measure. In particular the personal conferences between station officers and representatives of this Office have increased in number and importance. This has enabled the Office to get a more thorough understanding of the problems of station work, and to bring its influence more directly to bear on the development of the station enterprise. Especial efforts have been made to aid the movement for the strengthening of agricultural education and research through the more definite formulation of agricultural science and the more thorough training of agricultural experts. For this purpose the work of this Office, in connection with the Graduate School of Agriculture, held at Columbus, Ohio, in July, 1902, has proved to be unusually successful and effective. Attempts have also been made to call the attention of the agricultural public and the managers of educational systems to the great desirability of making agricultural subjects a part of the curricula of secondary and elementary schools. The development of the farmers' institutes as effective agencies for the dissemination of the results of the work of this Department and the experiment stations has also received attention. The agricultural experiment stations under the direct management of this Office in Alaska, Hawaii, and Porto Rico have been put upon a firm basis, and much progress has been made in developing useful lines of work in these regions. The Office has been brought into closer relations with the institutions for agricultural research in foreign countries through work involved in the preparation of a bulletin setting forth the organization, resources, and lines of work of these institutions. By this means our knowledge of these foreign institutions has been greatly broadened, and it will be more feasible hereafter to secure definite information regarding their

work, which will be useful to similar institutions in this country. Both the legal and engineering features of the irrigation investigations have been enlarged and a beginning has been made of investigations in other lines of agricultural engineering which have hitherto been neglected by this Department. Improvements have been made in the apparatus and methods for nutrition investigations. The results of these investigations have been more effectively brought to the attention of teachers of physiology and domestic science, and beginnings have been made of what it is hoped may develop into a systematic study of dietaries in public institutions.

The amount of material prepared for publication during the year has been greater than in any previous year. Special efforts have been made to publish this material in forms which will contribute to its effective and economical distribution. The Office has continued to perform considerable labor in connection with expositions, and has in prospect the continuance of such work in connection with the St. Louis Exposition. The performance of duties growing out of the relations of the Department with the Civil Service Commission has also involved considerable work.

In order to make the organization of the Office confirm more closely to that of other branches of the Department, having complex functions, as well as to more definitely recognize its rank as equal to that of a bureau, some changes have, by direction of the Secretary, been made in the plan or organization previously followed. At present the division and assignment of the work of the Office are as follows: (1) Relations with American and foreign institutions for agricultural education and research, including the supervision of the expenditures of the agricultural experiment stations in the United States, in the immediate charge of the director. (2) The Experiment Station Record, in charge of the assistant director, Dr. E. W. Allen. (3) Editorial division, Mr. W. H. Beal, chief. This division has in charge the editing of the technical and popular publications of the Office other than the Experiment Station Record. (4) Division of insular experiment stations, Dr. W. H. Evans, chief. This division is charged with the general business relating to the following experiment stations: (*a*) Alaska agricultural experiment stations, in charge of Prof. C. C. Georgeson, with headquarters at Sitka; (*b*) Hawaii Agricultural Experiment Station, in charge of Mr. Jared G. Smith, with headquarters at Honolulu; (*c*) Porto Rico Agricultural Experiment Station, in charge of Mr. Frank D. Gardner, with headquarters at Mayaguez. (5) Nutrition investigations, Prof. W. O. Atwater, chief, with headquarters at Middletown, Conn. (6) Irrigation investigations, Prof. Elwood Mead, chief, and Mr. C. T. Johnston, assistant chief. The position of chief clerk of this Office has been created and is filled by Mrs. C. E. Johnston.

LINES OF WORK.

The work of the Office of Experiment Stations during the past year, as heretofore, has included the supervision of the expenditures of the stations; conferences and correspondence with station officers regarding the management, equipment, and work of the stations; the collection and dissemination of information regarding the progress of agricultural education and research throughout the world by means of technical and popular bulletins; the management of the agricultural experiment stations in Alaska, Hawaii, and Porto Rico; and special investigations on the nutrition of man and on irrigation, conducted largely in cooperation with experiment stations, educational institutions, and other agencies in different States and Territories.

INCOME.

The income of the Office during the past fiscal year, derived wholly from appropriations by Congress, was as follows:

For the general business of the Office	$33,000
For the Alaska experiment stations	12,000
For the Hawaii Experiment Station	12,000
For the Porto Rico Experiment Station	12,000
For nutrition investigations	20,000
For irrigation investigations	50,000
	139,000

PUBLICATIONS.

During the year the Office issued 39 documents, aggregating 3,768 pages. These include 9 numbers of the Experiment Station Record, 16 technical bulletins, 2 reports, 6 farmers' bulletins, 2 circulars, and 4 articles for the Yearbook of the Department. There were also 57 articles, aggregating 1,257 pages, published as separates. Two other numbers of the Experiment Station Record and 6 bulletins, containing 1,116 pages, were prepared and submitted to the Division of Publications during the year. The plan has recently been followed of combining smaller articles on related subjects in larger reports and bulletins for limited circulation and employing separates to supply additional demands for the individual articles. This results in a saving of labor and expense and at the same time secures a more effective distribution of the publications.

The several reports annually made to Congress by this Office were the past year combined in one document, entitled the Annual Report of the Office of Experiment Stations.

Experiment Station Record, Vol. XIII, pp. 1206.—This contains abstracts of 378 bulletins and 59 reports of experiment stations in the United States, 205 publications of the Department of Agriculture, and 1,555 reports of foreign investigations. The total number of abstracts

is 2,800, and the total number of pages in the publications abstracted is 115,427. In addition, briefer reference is made to nearly 1,500 other articles which did not seem to call for extended notice. The total number of abstracts and titles together is 4,290, classified as follows: Chemistry, 326; botany, 182; fermentation and bacteriology, 47; zoology, 47; meteorology and climatology, 152; air, water, and soils, 127; fertilizers, 184; field crops, 475; horticulture, 486; forestry, 100; seeds and weeds, 82; diseases of plants, 291; entomology, 342; foods and nutrition, 252; animal production, 264; dairy farming and dairying, 264; veterinary science and practice, 385; technology, 24; agricultural engineering, 101; statistics and miscellaneous, 159.

This volume also contains special articles, as follows: "Agricultural experimental stations of Hungary;" "The ash constituents of plants, their estimation and their importance to agricultural chemistry and agriculture," by B. Tollens, published in two parts; "New agricultural building at Purdue University;" and "The station for plant breeding at Svalof, Sweden," by D. G. Fairchild. Condensed accounts of the proceedings of the eighteenth annual convention of the Association of Official Agricultural Chemists, and of the fifteenth annual convention of the Association of American Agricultural Colleges and Experiment Stations are included. The following topics are discussed in the editorials: Investigations of poisonous plants; the Hungarian experiment station system; statistics of agricultural colleges and experiment stations for 1900; need for investigation in stock breeding; organization of the Bureau of Soils; the use of funds for lease of college land grant; new agricultural building; Prof. Max Maercker, deceased; a school of practical agriculture and horticulture; farm practice in agricultural education; a graduate school of agriculture; the new bureau of agriculture for the Philippine Islands; Sir Joseph Henry Gilbert, deceased; agricultural education in England under the county councils; William Le Roy Broun, deceased; new aspects of agricultural education; the department of agriculture for Ireland; a new experiment station in England; the agricultural experiment stations of the world; cooperative fertilizer experiments in Germany; "euphorimetry," or the art of measuring the fertility of the soil; agricultural-meteorological observations in Russia; the agricultural appropriation act, 1902–3; J. Sterling Morton, third Secretary of Agriculture; cooperation in experimentation; progress of experiment stations abroad; meeting of farmers' institute workers at Washington; agricultural experiment stations for Victoria, Australia; permanent location of Porto Rico Station; an enthusiastic view of American stations and colleges; biological soil studies; a new departure in agricultural education, and the early literature of agriculture.

Miscellaneous technical bulletins.—These included articles on the evolution of reaping machines; results of investigations on the Rotham-

sted soils; agricultural experiment stations in foreign countries (accounts of 720 stations in 46 countries); some problems of the rural common schools; agricultural investigations in the island possessions of the United States; proceedings of the sixth annual meeting of the American Association of Farmers' Institute Workers; organization lists of the agricultural colleges and experiment stations in the United States; statistics of the land-grant colleges and agricultural experiment stations in the United States, and publications on nutrition and irrigation noted on pages 61 and 384, respectively.

Farmers' bulletins.—These included articles on irrigation in field and garden, how to build small irrigation ditches, principles of nutrition and nutritive value of foods, the feeding of farm animals, and three numbers of Experiment Station Work, with an index to Volume I of this series.

Card index.—Copy for 1,200 cards of the index of experiment station literature was prepared during the past year, and the number of index cards distributed reached 22,500.

AGRICULTURAL EXPERIMENT STATIONS IN ALASKA, HAWAII, AND PORTO RICO.

Agricultural experiment stations were regularly maintained during the past year, as heretofore, at Sitka and Kenai, and a new station was established on a temporary basis at Rampart, Alaska; the Hawaii Experiment Station was regularly organized and located at Honolulu; the Porto Rico Station was maintained on a temporary basis with headquarters at San Juan until the close of the fiscal year, when it was removed to Mayaguez, where it will be permanently located. For accounts of the work of these stations see pages 71, 91, and 163.

NUTRITION INVESTIGATIONS.

The investigations on the food and nutrition of man, carried on in different parts of the country, have been continued during the past year along substantially the same lines as heretofore.

With the aid of the increased appropriation of the past year it has been possible to undertake work in some new regions. According to the policy which experience has shown to be most effective the work has been done largely in cooperation with experiment stations, agricultural colleges, and universities, some of the leading institutions in the country being included in the list. By this cooperative method of conducting the investigations in different localities the work is given a broader scope and a wider influence than could otherwise be obtained by the expenditure of the amount of funds appropriated for the work, since usually the cooperating institutions give considerable assistance in the way of the services of skilled investigators, as well as laboratory supplies and facilities.

GENERAL PURPOSE AND PLAN OF THE INVESTIGATIONS.

The nutrition investigations the past year may be divided into four general classes: (1) Dietary studies; (2) digestion experiments; (3) cooking experiments, and (4) metabolism experiments.

The dietary studies have been conducted in various parts of the United States and have included the study of the diet of people of varying ages and occupations under different conditions. They furnish a large amount of data as to the actual food habits of persons in different parts of the country, give opportunity for comparison with the data obtained in other countries, and aid in establishing a general nutrition standard.

The digestion experiments have also been conducted in different parts of the country under widely varying conditions. By means of these experiments, the digestibility of various classes of food materials, such as meats, cereals, legumes, fruits, nuts, etc., is studied, and data are obtained as to the amount of food material consumed which is made available for use in the human body.

The cooking experiments have been made with meat, and have included the study of the effects of different methods of cooking upon meats of different kinds and cuts with reference to composition, digestibility, nutritive value, and pecuniary economy.

The metabolism experiments have been conducted mostly at Middletown, Conn., with the aid of the respiration calorimeter. In these experiments the income and outgo of the body (both matter and energy) were carefully observed and measured under different conditions of rest and work. The questions especially considered this year were (1) the relation between muscular work and the metabolism of nitrogen, and (2) the relative efficiency of fats and carbohydrates in the diet for severe muscular work. The results obtained have been unusually interesting and valuable.

All these experiments include a large amount of analytical work, as well as the determination of a considerable number of heats of combustion by means of the bomb calorimeter.

Considerable editorial work is required to put the results of the investigations in form for publication as either technical or popular bulletins. As would be expected, the increase in the amount of investigation has also resulted in an increase in the editorial work.

THE WORK AT DIFFERENT PLACES.

During the past year the work of the Washington office in connection with the nutrition investigations has included a general supervision of the plans and expenditures, editorial work in the preparation of bulletins and in perfecting the details of reports of investigations, the collection and compilation of the results of nutrition investigations

not generally available, the collection of bibliographical data and the abstracting of the current literature on nutrition, partly for publication in the Experiment Station Record, the conducting of a large correspondence growing out of nutrition investigations, and the distribution of publications on this subject.

The work in Middletown, Conn., at the office of Prof. W. O. Atwater, special agent in charge of nutrition investigations, has included the planning and direct supervision of these investigations in different parts of the country, the conducting of special investigations with the respiration and bomb calorimeter, the compilation of results of nutrition investigations in this country and abroad, correspondence relating to these investigations, and administrative work.

The special investigations at Middletown were under the more immediate charge of Dr. F. G. Benedict, and as heretofore were carried out in cooperation with the Storrs Experiment Station and with Wesleyan University. They include routine and special analytical work and metabolism experiments, which also comprise digestion experiments and an experimental study of methods of determining water in food samples. Attention has also been given to the improvement of the respiration calorimeter and other apparatus and methods of experimenting.

Prof. C. D. Woods, of the University of Maine, at Orono, has studied the digestibility and nutritive value of flour. During the past two years he has made 33 digestion experiments with bread made from different grades of wheat flour from the same lots of wheat. In connection with his work Professor Woods has also made a considerable study of methods of investigation, including the separation of feces. In addition to the digestion experiments, he has made four dietary studies with lumbermen performing severe work under unusual conditions.

Prof. Harry Snyder, of the University of Minnesota, at Minneapolis, has made investigations along the same lines as those followed by Professor Woods with flour of different grades ground from soft wheat, using the same samples as those worked upon during the year 1901–2 by Professor Woods. In connection with these investigations Professor Snyder conducted 15 digestion and nitrogen metabolism experiments with men on bread made from the different grades of flour eaten with milk.

At the University of Illinois, at Urbana, Prof. H. S. Grindley has continued his investigations on the losses involved in cooking meat of different kinds and cuts, and the comparative digestibility of meats so prepared, as determined by natural digestion experiments with man and by artificial digestion experiments under conditions designed to approximate those which obtain in the body. This work has included 19 cooking experiments, 14 digestion experiments with man, and 30 artificial diges-

tion experiments. In connection with the investigation much time has necessarily been devoted to a study of experimental methods and to analysis of different food and excretory products.

At the University of California, at Berkeley, Prof. M. E. Jaffa has continued his special investigations of the nutritive value of fruit and nuts. Seven dietary studies have been made with fruitarians consuming a diet of these materials eaten raw. Thirty-two digestion experiments have been made also to learn the thoroughness with which fruit and nuts are assimilated.

At Harvard University, Cambridge, Mass., Mr. Edward Mallinckrodt, jr., with the cooperation of Prof. C. R. Sanger, in 1900, carried on dietary studies with 10 students. Some of them were obliged to live very economically.

Several years ago Miss Amelia Shapleigh, under the supervision of Mrs. E. H. Richards, now of the Boston Institute of Technology, carried on an extended series of dietary studies with the families of workingmen. This material, which was never published in detail, has been furnished to this Office and has been edited during the past year, with the cooperation of Mrs. Richards, and is practically ready for publication. The report will also include the results of dietary studies made in 1901–2 at the Boston School of Housekeeping.

At the University of Vermont, located at Burlington, Prof. J. L. Hills has carried on 5 dietary studies; 1 with the family of a professional man and the others with farmers' families.

Prof. C. E. Wait, of the University of Tennessee, Knoxville, has carried on 4 dietary studies with members of white families in poor circumstances and 10 natural digestion experiments with men on a diet consisting principally of legumes. The work is in continuation of earlier investigations along the same lines.

Dr. H. C. White, president of the Georgia State College of Agriculture and Mechanic Arts, at Athens, has begun nutrition investigations with special reference to securing information regarding local food habits and food conditions. One thirty-day dietary study in the students' mess hall has been completed and additional investigations are planned for.

At Columbia University, New York City, Dr. H. C. Sherman has continued his investigations of the comparative metabolism of nitrogen, sulphur, and phosphorus, the work necessitating considerable study of methods and a large number of analyses.

FOOD AND NUTRITION PUBLICATIONS.

One popular and four technical bulletins were published during the year, in addition to one article contributed to the Yearbook for 1901, and a history of the development of the nutrition investigations pre-

pared for the annual report of this Office. The subjects treated in these publications are as follows:

Studies on bread and bread making at the University of Minnesota in 1899 and 1900; experiments on losses in cooking meat, 1898–1900; nutrition investigations among fruitarians and Chinese; experiments on the metabolism of matter and energy in the human body, 1898–1900; principles of nutrition and nutritive value of food; dietaries in public institutions; scope and results of the nutrition investigations of the Office of Experiment Stations.

An article on dietary studies in public institutions may be found on page 387.

IRRIGATION INVESTIGATIONS.

The irrigation investigations in charge of this Office have been conducted the past year, as heretofore, largely in cooperation with agricultural colleges, experiment stations, State engineer's offices, and organizations of citizens, and have included studies of the distribution and use of water, drainage problems, and the laws and institutions of agricultural communities dependent on irrigation in this country and abroad.

THE DISTRIBUTION AND USE OF WATER.

The Department is now making measurements of the water used in irrigation in all of the arid States but one, and in a number of humid States. The results of these studies during the past three years, while not conclusive, have already done much to educate farmers and ditch managers as to the direction from which improvements of methods and practices must come. They have made plain the need of better work in constructing and maintaining canals. They have shown that the water lost through leakage and transit is far greater than has been generally supposed. This loss causes a double injury. It returns in many instances to the surface of lower-lying fields and converts productive areas into unsightly swamps and marshes, rendering them for the time practically worthless. The loss of water through evaporation from these submerged areas is large. If this could be prevented and the water saved applied to crops, it would largely increase the cultivated area. One of the leading lines of work of these investigations will therefore be a more careful study of losses from seepage, in order to determine measures by which this can be lessened.

In a number of instances these studies have led to careful inquiries by canal owners to determine whether or not it will be profitable to cement the main ditches and canals, and to requests for further assistance from this Office to determine how this may be done to the best advantage. The annual report of irrigation investigations for 1901 will give the methods pursued and the cost of cementing one of the principal canals of southern California.

DRAINAGE SURVEYS.

In response to numerously signed petitions from the agricultural and horticultural interests of the Valley of the Kings River in California, the Department has carried on a comprehensive survey to determine what plans can be best adopted for relief of the overwatered lands of that section. This work has been done under the direction of Prof. O. V. P. Stout, agent and expert, and the report, which is now approaching completion, will give the plans and estimates for two methods of removing the surplus water and making it available for use elsewhere. The carrying out of these plans will probably require additional legislation on the part of the State, and a local committee has been formed to frame bills and promote the enactment of needed laws.

At the request of Hon. A. J. McCune, State engineer of Colorado, the Department has assisted in the investigation of the drainage problems of that State. This work is under the direction of C. G. Elliott, agent and expert, a drainage engineer of wide experience. The information already gained makes it certain that these studies are to be worth many times their cost, both to the localities where they have been carried on and in their influence on the larger and better use of the water supply. Some fears have been originally expressed that the water coming from these drains would be unfit for use because of the large percentage of alkali it contained, but analyses made by the State experiment stations of Colorado and California have shown that this is not the case.

STUDIES OF IRRIGATION LAWS.

The larger problems which the complete use of Western rivers is destined to create and the measure of public control which recent irrigation legislation renders inevitable gives added interest to the Department's studies of the legal and economic phases of irrigation. The division of the water of streams among the farms scattered for hundreds of miles along their courses, so that each acre of cultivated land shall receive its just share of the common water supply, is one of the most complex administrative problems which confront Western agriculture, and the establishment of titles to these streams by methods which shall prevent speculative appropriations of water and the creation of water monopolies, is one of the imperative needs of the immediate future.

A beginning of the studies of the conditions and experiences of other countries was made during the past year. Mr. C. T. Johnston, assistant chief of these investigations, visited Egypt for this purpose. Through the courtesy of Government officials he was enabled to become fully acquainted with the administration of the laws which govern the use of the Nile, and his report will show the character of the rights

to water recognized and the manner in which these rights are enforced in times of scarcity. While differences in conditions will doubtless prevent the adoption of many of the methods pursued, the lesson of one of the oldest irrigated countries in the world can not fail to have great interest and value to one of the youngest. In addition, Mr. Johnston's report will present many matters of practical information regarding the size and construction of canals, the manner in which water is distributed and applied to crops, and the yield and value of the products.

A number of the arid States are cooperating with the Department in these studies of social and legal problems. Montana and Nevada appropriated money for such studies, and the irrigation officials of Wyoming, Colorado, and Idaho have given both personal and official aid. No branch of the Department's irrigation work has received more cordial recognition than its studies of legal and social questions, and it is believed that they are destined to exert a beneficent influence on the future industrial life of the West.

IRRIGATION IN THE HUMID STATES.

The development of the rice industry in Louisiana and Texas has had the effect of enormously increasing the value of land hitherto used only for grazing purposes or not at all. Its success has led to the investment of large sums of money and a marked increase in the population. In the amount of money invested in canals and pumping plants and in the increase in the acreage reclaimed, the rice districts of Louisiana and Texas have made as great progress during the past two or three years as any of the irrigated districts of the West. This rapid growth has given rise to a number of practical problems in which the aid of the Department has been invoked. Establishing and maintaining pumping plants requires a knowledge of the amount of water required, the cost of furnishing it, and the methods by which waste in use may be reduced to the minimum. The light rainfall of the past two seasons has also made it manifest that the time is not far distant when there will be need for establishing rights to the use of streams and some division of their water supply among these irrigators. During the present season the rainfall from June to September was little more than that of many of the arid States, and this, combined with the large increase in the irrigated acreage, has made such drain on some streams that their currents have been reversed, causing salt water to flow in from the Gulf.

The growth of irrigation in the Southern States is not, however, confined to the rice districts. During the past year the experts of this investigation have furnished information and advice to farmers in Georgia, Alabama, and the Carolinas, under which a number of irrigation systems have been installed. The drought of the present season

has made the first year's trial a marked success, but it will require a number of years to determine to what extent irrigation can be profitably employed in this section. The fact that the Department was able to answer these inquiries has saved large sums of money to individual farmers. In nearly every instance they had planned to put in pumps of too small capacity to have been of any real service, and the attempts would have resulted in disappointment and loss and probably have delayed the adoption of what promises to be an important aid to both agriculture and horticulture.

The cooperative irrigation studies being carried on in connection with the State experiment stations of Wisconsin, Missouri, and New Jersey have been continued, the object being to determine how far and by what method irrigation can be profitably employed in the humid States.

A more detailed account of the irrigation investigations during 1902 is given on page 359.

AGRICULTURAL ENGINEERING.

In order to answer the inquiries received by the Department and to make the irrigation investigations of the greatest practical benefit, it has been necessary to give attention to studies of the application of power, the relation of which to irrigation is only made apparent by a thorough understanding of existing conditions. Farmers depending upon irrigation apply to the Department for information regarding the use of streams and canals for power purposes. Many who desire to irrigate small tracts apply to the Department for information as to whether or not pumping will pay, the kind of pumps to be used, and the amount of water required. Inquiries are received as to the relative economy of different forms of power, and whether coal, oil, gas, electricity, or wind power will best serve the irrigator's purposes. These questions should be answered, because nothing is more wasteful than to have each man learn experimentally for himself what has been found out elsewhere; but doing this makes agricultural engineering an important feature of these investigations and raises the question whether the usefulness of the work of this Department can not be materially augmented by entering upon a systematic study of this subject.

The possibilities of this subject can be illustrated by the one item of farm machinery. In the past twenty years the capital invested in the manufacture of agricultural implements has increased from sixty to one hundred and fifty-seven millions and the value of the product has more than doubled, but more significant than this increase in its importance have been the changes in its character. Leaving out of consideration the larger and more important classes of farm machinery, such as reapers, mowers, and thrashers, which are usually thought of as sup-

porting the claim that American inventive genius and mechanical skill have surpassed the world in constructing farm machinery, and taking up machines and implements but little thought of in this connection, it will be seen that the changes wrought in the past twenty years have been little less than revolutionary and have been an important factor in maintaining our commercial supremacy. The invention of the disk harrow to supplement the types formerly used, the invention of the disk plow to compete with the types in use for centuries, the still more recent invention of corn-harvesting machinery, all serve to show the rapidity and radical character of the evolution which is now going on.

These facts, in connection with the increasing demand for efficient labor-saving devices resulting from the growing scarcity of farm labor, and the organization and development in foreign countries of institutions for the systematic study and improvement of farm machinery, render it important that we should not longer neglect this field of inquiry, or at least afford an opportunity to the Department to do an important service in promoting our continued progress.

At present the Department is not in a position to answer the numerous requests for information on these subjects, and these demands will undoubtedly increase with the growing application of new forms of power to farm work and the development of new kinds of labor-saving machinery. The agricultural experiment stations throughout the country are beginning to realize the need of such studies, but they find great difficulty in establishing the work on an efficient basis, owing to the lack of definite information in available form. It is believed that this Department should undertake to collate and publish such information, as well as to institute investigations which will keep the farmers of the country informed of the progress being made.

These investigations should also include the laying out of farms, including the arrangement of buildings, drains, water supply, and disposal of sewage. The character of the agriculture of the twentieth century has made farm buildings as complex in design and varied in use as factories, and there is a wide field of study for improvement in design and for determination of the best material to be used in their construction.

The breeders of high-bred and valuable live stock need to give almost as much attention to stable sanitation as is given to house sanitation, but the data on which to plan efficient systems of ventilation is of the most limited character. It is believed that careful studies of the designing of farm buildings will be a benefit to agriculture, not only in saving large sums of money in the selection and combination of material used, but in the adoption of more convenient and effective plans.

THE AGRICULTURAL EXPERIMENT STATIONS IN THE SEVERAL STATES AND TERRITORIES.

ALABAMA.

Agricultural Experiment Station of the Alabama Polytechnic Institute, *Auburn*.

Department of the Alabama Polytechnic Institute.

GOVERNING BOARD.

Board of Trustees—Committee on Experiment Stations: Thomas Williams (*President,*) *Wetumpka;* Jonathan Haralson, *Montgomery;* J. M. Carmichael, *Montgomery.*

STATION STAFF.

Chas. C. Thach, M. A., *Acting Director.*
B. B. Ross, M. S., *Chemist.*
C. A. Cary, B. S., D. V. M., *Veterinarian; in Charge of Farmers' Institutes.*
J. F. Duggar, M. S., *Agriculturist.*
E. M. Wilcox, Ph. D., *Biologist, Botanist.*
R. S. Mackintosh, B. Agr., *Horticulturist.*
R. P. Burke, *Assistant Biologist.*
J. T. Anderson, Ph. D., *Associate Chemist.*
C. L. Hare, M. S., *First Assistant Chemist.*
Thomas Bragg, M. S., *Second Assistant Chemist.*
J. C. Phelps, M. S., *Third Assistant Chemist.*
T. U. Culver, *Farm Superintendent.*
R. W. Clark, *Assistant Agriculturist.*
G. F. Freeman, *Student Assistant to Director.*

GENERAL OUTLOOK.

The Alabama Station is continuing the lines of work related to soil improvement and the diversification of agricultural operations in the State. Much attention is being given to growing leguminous crops as soil renovators and to related investigations regarding the inoculation of soils, the sources of nitrogen in the soil, and the micro-organisms of root tubercles on various legumes. The soil on which vetch and crimson clover has been grown is being distributed for inoculating other soils. An effort is being made to determine the duration of effects from the use of legumes, manures, and commercial fertilizers. Efforts are also being made to promote animal husbandry in the State, and in this connection many cereals and forage plants are being tested with reference to their adaptability to the climate and soil and their value for pasture, soiling, or hay. Pork production by feeding hogs different local products and by pasturing them on peanuts, chufas, sorghum, and cowpeas is receiving considerable attention, as is also the influence of different feeds on the quality of pork. Irrigation

experiments with garden vegetables have been continued, and plans are being made to improve the heating plant in the new greenhouse in order to undertake forcing experiments with vegetables. The station is cooperating with the Bureau of Plant Industry of this Department in tests of novelties introduced by the seed trade. A drought during the last season, the most severe in years, rendered many of the field experiments of little value. At the close of the year the director and botanist of the station resigned to become president of Clemson College and director of the South Carolina Agricultural Experiment Station.

The Alabama Station is located on a high, sandy ridge in one of the poorest sections of the State. Most of the soil on the station farm has been badly run down and overrun with weeds, so that any results there obtained ought not to be difficult to obtain elsewhere. Persistent efforts along the lines of soil improvement and the introduction of animal husbandry have resulted in arousing considerable interest in these subjects as indicated by the growing bulletin list and the increasing correspondence of station officials. Cooperative work with farmers is an important agency for introducing improved varieties, new crops, and better farming methods, and the same is true of farmers' institute work conducted by the veterinarian of the station, who is assisted by several other members of the staff. Several promising new varieties of cotton have been developed, and considerable success has attended the experiments with legumes for green manure.

With the growth of the fertilizer inspection work and the making of numerous analyses of miscellaneous materials required by State laws, the investigations of the station apparently do not receive as much aid as formerly from the fertilizer fund. The farmers' institute work is also an increasing burden on the station. There is, therefore, need of additional State funds to enable the station to conduct its investigations in a more thorough and efficient manner, and on a scale commensurate with the agricultural interests of the State.

LINES OF WORK.

The principal lines of work conducted at the Alabama Station during the past year were as follows: Botany—grasses, native trees, varieties of cotton; soils—renovation with leguminous plants; analyses of fertilizers and food materials; field and pot experiments—fertilizers, barnyard manures, cereals, cotton, forage crops; horticulture—varieties of strawberries and other fruits and asparagus, irrigation of garden vegetables; plant breeding—cotton, cowpeas; diseases of plants; feeding experiments—beef and dairy animals and hogs; diseases of animals; dairying—milk, butter, and cheese production.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees for the analysis of fertilizers, etc	5,201.66
Farm products	736.59
Total	20,938.25

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 114–120, Index to Volume IX, and the Annual Report for 1901. These bulletins include reports on feeding experiments with dairy cows, Texas or acclimatization fever, orchard notes, cowpea culture, the flora of the metamorphic region, and the cowpea and the velvet bean as fertilizers. This last bulletin records the results of more than 50 experiments conducted at Auburn during the past five years to ascertain the effects of these plants on the improvement of the soil. The investigations show clearly the importance of such a rotation of crops as will require a large proportion of the cultivated land of every farm to be devoted to some leguminous crop. The bulletin mailing list has been revised. It is growing rapidly, as is also the station correspondence regarding live stock, hay making, and other subjects, indicating a growing realization of the importance of diversified farming.

Canebrake Agricultural Experiment Station, *Uniontown.*

GOVERNING BOARD.

Board of Control: R. R. Poole (*Commissioner of Agriculture, ex officio*), *Montgomery;* J. Huggins, *Newbern;* A. Sledge, *Whitsett;* G. D. Stollenwerck, *Uniontown;* M. Walker, *Faunsdale;* W. M. Munford, *Uniontown.*

STATION STAFF.

J. M. Richeson, M. S., *Director, Secretary.* M. Walker, *Treasurer.*
J. F. Connor, V. M. D., *Veterinarian.*

GENERAL OUTLOOK.

The attention of the staff of the Canebrake Station is directed mainly to the use of legumes, fertilizers, and barnyard manure as means of improving the worn-out soils of the prairie region. The principal legumes used are cowpeas, melilotus, and different varieties of beans,

vetches, and clover. Some attention is being given to tile drainage, deep and shallow cultivation of corn, and to experiments with upland rice, flax, and fruits of different kinds.

LINES OF WORK.

The principal lines of work conducted at the Canebrake Station during the past year were as follows: Soil improvement; field experiments; horticulture; floriculture; diseases of plants; and diseases of animals.

The income of the station during the past fiscal year was as follows:

State appropriation	$2,500

No publications have been issued by the station during the past year.

Tuskegee Agricultural Experiment Station, *Tuskegee.*

Department of the Tuskegee Normal and Industrial Institute.

GOVERNING BOARD.

Board of Regents: R. R. Poole, *Montgomery;* Geo. W. Campbell, *Tuskegee;* Chas. W. Hare, *Tuskegee;* Lewis Adams, *Tuskegee;* Booker T. Washington, *Tuskegee;* Warren Logan, *Tuskegee.*

STATION STAFF.

G. W. Carver, *Director.*
R. M. Attwell, *Farm Superintendent.*
C. W. Greene, *Practical Agriculture, Home Farm.*
W. J. Claytor, *Stock Raising.*
G. W. Owens, *Dairying.*
B. T. Crawford, *Dairying.*
L. J. Watkins, *Landscape Gardening.*
W. C. Smith, *Landscape Gardening.*
D. A. Williston, *Landscape Gardening.*
F. H. Cardoza, *Horticulture.*
C. J. Calloway, *Bureau of Nature Study.*

GENERAL OUTLOOK.

Demonstration experiments with various soil renovators, including a number of legumes, have been continued with considerable success. The iron pea proved to be one of the best drought-resistant legumes tried during the past year. Experiments are also conducted with grasses, corn, sweet and Irish potatoes, cotton, cabbage, cassava, etc. An orchard of nearly 5,000 peach trees is coming into bearing, and 2,000 more will be set out soon. A plantation of 300 mulberry trees has been set out preparatory to conducting some experiments in silk culture. The station has over 600 swine, a large herd of dairy cows, and many horses and mules, all of which are being handled in a way to demonstrate the feasibility of introducing stock raising into the South. Two pure-bred stallions have recently been purchased, one a hackney and the other a French coach. The monthly farmers' conferences and the annual conference of farmers from all over the State have been valuable features of the work of the station during the year. The influence of the station upon farm methods in the vicinity of Tuskegee has been quite marked.

LINES OF WORK.

The principal lines of work conducted at the Tuskegee Station during the past year were as follows: Field experiments; horticulture; diseases of plants; animal industry; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

State appropriation	$1,500

PUBLICATIONS.

No publications have been issued, it having been found that the station could exert its influence most effectually through conferences of farmers.

ALASKA.

Alaska Agricultural Experiment Stations, *Sitka, Kenai,* and *Copper Center.*

Under the supervision of A. C. True, Director, Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

C. C. Georgeson, M. S., *Special Agent in Charge, Sitka.*
F. E. Rader, *Assistant at Sitka.*
Hans P. Nielsen, *Assistant at Kenai.*
J. W. Neal, *Assistant at Copper Center.*

GENERAL OUTLOOK.

Agricultural experiment stations were maintained during the past fiscal year at Sitka, Kenai, and Rampart. The experimental work has included the growing of cereals and vegetables, methods of reclamation, drainage, and fertilization of land, and the curing and ensiling of forage crops. In all these lines successful results were obtained, and much information which will be of use to persons attempting agriculture in Alaska was acquired. The survey of different portions of Alaska with reference to their agricultural possibilities was continued. The special agent in charge made a journey through a large portion of the Yukon River Valley. A reconnoissance of the Copper River region and portions of the Fortymile country and the Tanana River Valley was made during September, 1901, by the assistant who had been in charge of the station work at Rampart. He estimated that in the region covered by his journey there was some 2,000,000 acres of land suitable for farming and pasture. Grass grew abundantly and luxuriantly in large regions. A station has been established in the Copper River Valley, and an assistant has been appointed to take charge of the work.

The distribution of seed of hardy varieties of vegetables, cereals, and grasses has been continued and extended, seed for use the present

season having been sent to some 750 addresses. Many reports of trials of seed previously sent have been received, and in this way much useful information has been secured. It is evident that the efforts made by the Department to aid the residents of Alaska in their agricultural work by distributing improved varieties of seeds have produced beneficial results, not only among the white population, but also among the natives, an increasing number of whom have attempted to cultivate small patches of ground.

The equipment of the Alaska stations has been increased in several ways. At Sitka further work on the headquarters building has been done, and the roof of the barn has been extended so as to include under one roof a silo, stalls for four head of cattle, seed and implement rooms, and rooms for the storage of crops. A cottage for the farm foreman and a small blacksmith shop have been built. The small station building at Kenai has been completed and furnished, and a telephone line nearly a mile long has been constructed at Sitka between the headquarters building and the farm.

A beginning has been made toward the establishment of a nursery by propagating a number of currant, gooseberry, and raspberry bushes, and by procuring small collections of hardy fruit trees, ornamentals, and strawberries. It is hoped that soon a small propagating house can be constructed, the headquarters building completed, and chemical supplies for simple analyses procured. It is also planned to secure as soon as possible a small herd of cattle, to be used in animal husbandry experiments at Kenai, and a small flock of Angora goats, with a view to ascertaining whether these animals can be successfully reared in the coast region of southern Alaska, where the native plants will furnish abundant forage for goats.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation	$12,000

LINES OF WORK.

The principal lines of work conducted at the Alaska stations during the past fiscal year were as follows: Field experiments with cereals, fiber plants, vegetables, and grasses; tests of methods of reclamation, drainage, and fertilization of land; curing and ensiling of forage crops; horticulture—propagating currant, gooseberry, and raspberry plants, experiments with hardy fruit trees, ornamentals, and strawberries; and meteorological observations.

PUBLICATIONS.

This Office has issued during the past fiscal year Bulletin 1 of the Alaska Experiment Stations, giving directions for the preparation of

the soil and the planting of a number of crops adapted to Alaska conditions. The sixth report on the investigations in Alaska, giving a detailed account of the operations during the year 1902, has been prepared by the special agent in charge of Alaska investigations, and is given on page 233.

ARIZONA.

Agricultural Experiment Station of the University of Arizona, *Tucson.*

Department of the University of Arizona.

GOVERNING BOARD.

Board of Regents: Ferris S. Fitch (*Chancellor*), *Tucson;* James A. Zabriskie (*Secretary*), *Tucson;* J. M. Ormsby (*Treasurer*), *Tucson;* Winfield Scott, *Scottsdale;* Governor A. O. Brodie (*ex officio*), *Phoenix;* N. G. Layton (*Superintendent of Public Instruction, ex officio*), *Phoenix.*

STATION STAFF.

R. H. Forbes, M. S., *Director; Chemist.*
A. J. McClatchie, M. A. (*Phoenix*), *Agriculturist, Horticulturist.*
T. F. McConnell, jr. (*Phoenix*), *Animal Husbandman.*
J. J. Thornber, M. A., *Botanist.*
W. W. Skinner, M. S., *Associate Chemist.*
T. D. A. Cockerell (*East Las Vegas, New Mexico*), *Consulting Entomologist.*
S. M. Woodward, M. A., *Consulting Meteorologist.*
W. O. Hayes, *Clerk.*

GENERAL OUTLOOK.

Range improvement, irrigation investigations, the introduction of new crops, and animal husbandry are the subjects given prominence at the Arizona Station during the past year. The efforts to improve range conditions by building retaining embankments, seeding with grasses, and keeping cattle off the ranges have given good results. This work is conducted in cooperation with the Bureau of Plant Industry of this Department. The station is also cooperating with the Bureau of Plant Industry in its work with date palms which has been quite successful thus far. The palms at Phoenix last year yielded several hundred pounds of dates, and a new plantation has been made on the station grounds at Phoenix. Among other crops introduced the Egyptian cotton has done well, and potatoes are being grown commercially by the agriculturist on his own farm. The cooperative sugar-beet investigations have been brought to a close. It has been demonstrated that sugar beets in satisfactory quantities and of a fairly satisfactory quality may be produced in the irrigated valleys of southern Arizona. Strawberries are now being investigated with a view to improving the system of setting plants and irrigating them. The experiments in animal husbandry are attracting considerable attention. Experiments in pasturing cattle have not been entirely satisfactory, and soiling experiments will be tried. The meteorologist

has made an interesting study of the heat from the sun on buildings of different shapes, and has published the results of his studies, which include practical recommendations regarding the construction of buildings of suitable shape for the climate of Arizona. The study of irrigation problems has been another important line of work, and has included the study of irrigating waters with reference to their character and effect upon irrigated soils, and the economical and effective use of water in connection with irrigated crops. In addition to the cooperative enterprises mentioned above, the station is cooperating with the Bureau of Chemistry of this Department in studying the effect of environment on the sugar content of muskmelons, and with the Bureau of Soils in making a soil survey.

The station is making substantial progress, and is successful in developing useful lines of work and in securing the support of the agricultural people of the Territory. As an indication of the favor in which the work of the station is held, the Territorial legislature recently made appropriations for the university which included an item of $2,300 for the station. This is the first appropriation of the kind ever made in Arizona and is encouraging to those who have the interests of the college and station at heart.

LINES OF WORK.

The principal lines of work conducted at the Arizona Station during the past year were as follows: Chemistry—study of irrigation waters and their effects upon irrigated soils; botany; field experiments—cereals, forage crops; irrigation investigations; improvement of ranges; horticulture—date-palm growing, melons, vegetables, fruits, etc.; and feeding experiments—beef and dairy cattle, sheep, and hogs.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	940.36
Farm products	879.10
Miscellaneous, including balance from previous year	113.60
Total	16,933.06

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 38–42 and the Annual Report for 1901. The bulletins include a reprint of Timely Hints for Farmers, which have been very

well received throughout the Territory; dairy herd records, and reports of the soil survey in Salt River Valley, and of the irrigation investigations at the station farm. The results of the meteorologist's studies of the heat of the sun on buildings have been published under the title, The Cool Side of a House in Arizona.

ARKANSAS.

Arkansas Agricultural Experiment Station, *Fayetteville.*

Department of the University of Arkansas.

GOVERNING BOARD.

Board of Control—Agricultural Committee: Henry L. Stroup (*President*), *Paris;* H. N. Pharr, *Lagrange;* V. Y. Cook, *Elmo;* H. S. Hartzog (*President University*), *Fayetteville;* R. L. Bennett, *Fayetteville.*

STATION STAFF.

R. L. Bennett, M. S., *Director.*
R. R. Dinwiddie, M. D., *Pathologist, Bacteriologist.*
Ernest Walker, B. S. Agr., *Horticulturist, Entomologist.*
C. L. Newman, B. S., *Agriculturist.*
J. F. Moore, B. S., *Chemist.*
G. B. Irby, B. A., *Assistant Agriculturist at Newport.*

GENERAL OUTLOOK.

The lines of investigation conducted at the Arkansas Station have not been changed materially during the past year. The investigations on tuberculosis have been discontinued for the present, but those with swine, including feeding experiments at Newport and studies of swine diseases, are still in progress, and a thorough investigation of the cause of injury to pigs from eating cotton-seed meal has been undertaken with good prospects for successful results. Considerable attention has been given to studies of the residual effects of legumes and manures and to the introduction of new crops. In this category may be mentioned alfalfa, regarding which the station has recently issued a circular in answer to the numerous questions regarding the methods of growing it; celery and winter cabbage, which have been grown with great success; oats, comparatively unknown among the farmers of the State, and muskmelons, regarding which much interest has been aroused by a bulletin giving the experience at the station in their production. Breeding and selection experiments with cowpeas to get varieties yielding more vine and more seed have been successful, and selection experiments with wheat and oats to increase the weight of grain have been undertaken. A careful study has been made of the causes of apple tree failure in two of the principal apple-growing counties of the State. The importance of this work is shown by the fact that last year these two counties (Washington and Benton) produced an apple crop worth $2,406,000. A rice-growing experiment in

cooperation with farmers in the southern part of the State has been inaugurated.

The station is introducing new industries in the State and developing those already established along improved lines. Hog raising is an important industry and is receiving much attention. Many acres in the State are suitable for truck gardening, and the successful production of such valuable staples as celery, cabbage, and muskmelons is a result of great economic importance. The work with muskmelons, it is said, resulted in one company putting out this year 400 acres of this crop. In some ways the station is coming into closer relation with its constituents, but there is need of means for giving greater publicity to its work. Station bulletins reach but a small percentage of the rural population and could well be supplemented with press bulletins on timely topics. The farmers' institute, another excellent agency for the dissemination of information regarding the station, is not organized in Arkansas, and the lack is keenly felt.

LINES OF WORK.

The principal lines of work conducted at the Arkansas Station during the past year were as follows: Chemistry of foods—lard and oils used in cooking, effect of different feeds on the quality of the fat of hogs; field experiments—selection of wheat and oats; horticulture—apples, peaches, small fruits, and garden vegetables; plant breeding—cowpea; diseases of plants; feeding experiments—pasturing swine on peanuts, chufas, etc.; and diseases of animals—swine plague, swine pest, and investigation of methods for applying vaccine.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,230.57
Total	16,230.57

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–71 and the Annual Report for 1901. The subjects upon which results have been published are experiments with oats, swine diseases in Arkansas, soil improvement and forage experiments, muskmelon experiments, cowpea experiments, and why apple trees fail.

CALIFORNIA.

Agricultural Experiment Station of the University of California, *Berkeley.*

Department of the University of California.

GOVERNING BOARD.

The Regents of the University: Gov. G. C. Pardel (*ex officio President*), *Sacramento;* Jacob H. Neff, *1154 O'Farrell street, San Francisco;* C. W. Pendleton, *204 Byrne Building, Los Angeles;* T. J. Kirk (*State Superintendent of Public Instruction*), *Sacramento;* A. B. Spreckels, *327 Market street, San Francisco;* R. J. Taussig, *26 Main street, San Francisco;* Benjamin Ide Wheeler, *1820 Scenic avenue, Berkeley;* Isaias W. Hellman, *Nevada Bank, San Francisco;* J. F. Houghton, *Safe Deposit Building, San Francisco;* Chester Rowell, *Fresno;* J. A. Waymire, *Alameda;* C. W. Slack, *Nevada Block, San Francisco;* J. B. Reinstein, *217 Sansome street, San Francisco;* J. E. Budd, *Stockton;* Mrs. Phœbe A. Hearst, *Mills Building, San Francisco;* C. N. Ellinwood, *San Francisco;* A. W. Foster, *Mutual Life Insurance Building, San Francisco;* Garrett W. McEnerney, *Nevada Block, San Francisco;* George C. Pardee, *Chronicle Building, San Francisco;* C. S. Wheeler, *532 Market street, San Francisco;* G. C. Earl, *2739 Pacific avenue, San Francisco.*

STATION STAFF.

E. W. Hilgard, Ph. D., LL. D., *Director; Chemist.*
E. J. Wickson, M. A., *Horticulturist.*
W. A. Setchell, Ph. D., *Botanist.*
R. H. Loughridge, Ph. D., *Agricultural Geology and Soil Physics* (*Soils and Alkali*).
C. W. Woodworth, M. S., *Entomologist.*
J. Burtt Davy,[a] *Assistant Botanist.*
M. E. Jaffa,[a] M. S., *Assistant Chemist* (*Foods and Fertilizers*).
G. W. Shaw, Ph. D., *Assistant Chemist* (*Soils and Beet Sugar*).
George E. Colby, M. S., *Assistant Chemist* (*Fruits, Waters, and Insecticides*).
H. M. Hall, M. S., *Assistant Botanist.*
Leroy Anderson, Ph. D., *Animal Industry, San Luis Obispo.*
A. R. Ward, B. S. A., D. V. M., *Veterinarian, Bacteriologist.*
E. H. Twight, B. S., Diplomé E. A. M., *Viticulturist.*
E. W. Major, B. Agr., *Dairy Husbandman*
C. A. Triebel, Ph. G., *Student Assistant in Agricultural Laboratory.*
W. T. Clarke, *Assistant Entomologist.*
A. V. Stubenrauch, M. S. A., *Assistant Horticulturist and Superintendent Substations.*
Emil Kellner, *Foreman Grounds.*
C. A. Colmore, *Clerk to Director.*

OUTLYING STATIONS.

Southern Coast Range Station: S. D. Merk, *Patron, Paso Robles;* J. H. Ooley, *Workman, Paso Robles.*

San Joaquin Valley Station: John Tuohy, *Patron, Tulare;* Julius Forrer, *Foreman, Tulare.*

Sierra Foothill Station: R. C. Rust, *Patron, Jackson;* J. H. Barber, *Foreman, Jackson.*

Southern California Station: S. N. Androus, *Patron, Pomona;* James W. Mills, *Foreman, Ontario.*

Chico Forestry Station: V. C. Richards, *Patron, Chico;* T. L. Bohlender, *Workman in Charge.*

Santa Monica Forestry Station: Roy Jones, *Patron, Santa Monica;* William Shutt, *Foreman, Santa Monica.*

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[a] On leave.

GENERAL OUTLOOK.

The California Station is investigating a wide range of subjects related to the principal agricultural and horticultural interests of the State. The soils of the State with reference to their chemical and physical condition and the methods of handling them have come in for a large amount of attention. The many and varied fruit products and their diseases and insect enemies furnish another group of problems demanding and receiving such attention as the station is able to give. Investigations in cooperation with this Department have been arranged as follows: Planting and testing sand-binding plants with the Bureau of Plant Industry; investigation of the gluten content of wheat and sugar-beet investigations with the Bureau of Chemistry; nutrition and irrigation investigations with this Office. The botanist of the station is also cooperating with about 30 farmers in different parts of the State in conducting green-manuring experiments. Work at the substations on problems of local significance has been continued as heretofore. The inspection of Paris green and the analysis of individual samples of water, soil, etc., are becoming rather onerous and expensive duties.

The wide range of latitude, elevation, and other physical conditions in California, resulting in great diversity of productions, necessitate the investigation of a great variety of problems, many of which are local in nature. An attempt has been made to meet these needs by the maintenance of a number of substations, but the results have not been entirely satisfactory, owing largely to inadequate financial resources to carry through all the work undertaken in response to the popular demand. Until the State shall provide increased funds for the support of experiments in different agricultural regions the number of substations should be reduced and the work concentrated on a few of the most important problems.

LINES OF WORK.

The principal lines of work conducted at the California Station during the past year were as follows: Physics; chemistry and geographical distribution of soils; bacteriology; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; beet-sugar chemistry; chemistry of foods and feeding stuffs; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; and plant introduction.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	11,923.00
Farm products	549.22
Total	27,472.22

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 132–140 and Seed Bulletin 1901–2, entitled Distribution of Seeds and Plants. The subjects of the regular bulletins are as follows: Feeding of farm animals, tolerance of alkali by various cultures, report on condition of vineyards in portions of Santa Clara Valley, the potato worm in California, erinose of the vine, pickling ripe and green olives, citrus fruit culture, orange and lemon rot, and lands of the Colorado Delta in the Salton Basin.

COLORADO.

Agricultural Experiment Station, *Fort Collins.*

Department of the State Agricultural College of Colorado.

GOVERNING BOARD.

The State Board of Agriculture: P. F. Sharp (*President*), *Denver;* A. M. Hawley (*Secretary*), *Fort Collins;* J. C. Chipley (*State Treasurer*), *Denver;* C. H. Sheldon (*Local Treasurer*), *Fort Collins;* B. F. Rockafellow, *Canon City;* Mrs. E. F. Routt, *Denver;* Jesse Harris, *Fort Collins;* Harlan Thomas, *Denver;* J. L. Chatfield, *Gypsum;* B. U. Dye, *Rockyford;* Gov. H. Peabody (*ex officio*), *Denver;* B. O. Aylesworth (*ex officio*), *Fort Collins.*

STATION STAFF.

L. G. Carpenter, M. S., *Director; Irrigation Engineer.*
C. P. Gillette, M. S., *Etomologist.*
W. P. Headden, M. A., Ph. D., *Chemist.*
Wendell Paddock, M. S., *Botanist, Horticulturist.*
G. H. Glover, B. S., D. V. M., *Veterinarian.*
A. H. Danielson, B. S., *Agronomist.*
F. M. Rolfs, B. S., *Assistant Horticulturist.*
A. M. Hawley, *Secretary.*
A. D. Milligan, *Clerk, Stenographer.*
Fred C. Alford, B. S., *Assistant Chemist.*
Earl Douglass, B. S., *Assistant Chemist.*
R. E. Trimble, B. S., *Assistant Meteorologist, Irrigation Engineer.*
S. Arthur Johnson, M. S., *Assistant Entomologist.*
Harvey H. Griffin, B. S., *Field Agent Arkansas Valley Substation, Rockyford.*
J. E. Payne, M. S., *Field Agent.*

GENERAL OUTLOOK.

The Colorado Station has made few changes in its lines of work during the past year. In a general way the field experiments and irrigation investigations have been broadened and the work at the substations much curtailed. The land of the Rockyford substation has been sold. The experimental portion of the farm has been set apart from the college farm and assistants in agronomy and zootechny have been employed. The agriculturist has resigned to accept the directorship of the Wyoming Station. The investigations in cooperation with this Department have been continued and other lines taken up so that now this feature of the station work includes experiments in growing

sugar-beet seeds and tests of forage crops for alkali and arid soils with the Bureau of Plant Industry, sugar-beet investigations and the study of available plant food in soils with the Bureau of Chemistry, a soil survey with the Bureau of Soils, and irrigation investigations with this Office.

The college with which the station is connected is having a larger attendance. The grade of the agricultural course has been raised one year. A college veterinary department has been established and a considerable number of improved live stock acquired by donation. Farmers' institutes have been conducted, but need a better organization and more funds to make them efficient. Both the college and the station are greatly in need of more liberal support, and this the State should provide. Otherwise it will be necessary for the station to drop some of the work it is now doing and devote its energies to a few of the most important lines of investigation. The progress which the station has made in concentrating its work under the direction of its expert staff is gratifying and gives promise of increased efficiency.

LINES OF WORK.

The principal lines of work conducted at the Colorado Station during the past year were as follows: Chemistry—analysis of soils and irrigation waters, sugar-beet investigations, studies of methods of analyzing feeding stuffs, etc.; field experiments—variety tests of wheat and oats for different altitudes; horticulture; diseases of plants; entomology—study of the codling moth, grasshoppers, various borers and leaf rollers, cutworms, and insects working on sugar beets and cantaloupes; irrigation—use of water, measurements of losses from ditches, study of means for economizing water, measurements of seepage on the Platte, the Arkansas, the Rio Grande, and their tributaries.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,036.26
Miscellaneous, including balance from previous year	1,989.83
Total	18,026.09

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 55 and 64–71, including the following subjects: Forests and snow, a soil study—III, the soil; relation of bovine to human

tuberculosis, tuberculin tests of the college herd, the distribution of water, powers and duties of irrigation officials under Colorado laws, pasture grasses, leguminous crops, cantaloupe blight, plant diseases of 1901, potato failures, insects and insecticides, and a reprint of Press Bulletins Nos. 1–11.

CONNECTICUT.

The Connecticut Agricultural Experiment Station, *New Haven.*

GOVERNING BOARD.

State Board of Control: Gov. Adrian Chamberlain (*President*), *Hartford;* W. H. Brewer (*Secretary*), *New Haven;* E. H. Jenkins (*Treasurer*), *New Haven;* W. O. Atwater, *Middletown;* Edwin Hoyt, *New Canaan;* J. H. Webb, *Box 1425, New Haven;* T. S. Gold, *West Cornwall;* B. W. Collins, *Meriden.*

STATION STAFF.

E. H. Jenkins, Ph. D., *Director.*
A. L. Winton, Ph. B., *Chemist.*
T. B. Osborne, Ph. D., *Chemist.*
A. W. Ogden, Ph. B., *Chemist.*
M. Silverman, Ph. B., *Chemist.*
I. F. Harris, Ph. B., *Chemist.*
W. E. Britton, B. S., *State Entomologist.*
Walter Mulford, F. E., *in Charge of Forest Work and State Forester.*
G. P. Clinton, S. D., *Botanist.*
V. E. Cole, *Librarian, Clerk.*
L. M. Brautlecht, *Assistant Clerk.*
William Veitch, *in Charge of Buildings and Grounds.*
Hugo Lange, *Laboratory Assistant.*
William Pokrob, *Laboratory Assistant.*
J. B. Olcott, *in Charge of Grass Garden* (*South Manchester*).
V. L. Churchill, *Sampling Agent.*

GENERAL OUTLOOK.

The Connecticut State Station has not made any radical changes in its lines of work. The study of vegetable proteids this year has been confined to an investigation of nucleic acid, the principal nitrogenous material of the cell nucleus. The experiments in raising Sumatra tobacco under shade, which were inaugurated in cooperation with the Bureau of Soils of this Department, have been continued with marked success. The crop of 1901 was much better in quality than the previous crop, and was sold at an average of $1.73 per pound, which is about four times the price obtained for good crops of fermented Connecticut Habana tobacco raised in the usual way. The results of these experiments have led to the growing of many acres of tobacco protected by cheese cloth in the Connecticut Valley. In connection with his inspection duties, the station entomologist has made a very complete census of the fruit growers of the State, kinds of fruit produced, acreage in fruit, and estimated yield in 1902, a work which has been of considerable value both to the growers and to the transportation companies. Considerable attention has been given during the year to a special study of the anatomy of the cocoanut and of a considerable number of the common small fruits, and the results have been pub-

lished as a contribution to the general knowledge of the subject. Two lines of investigation are directed toward the reclamation of uncultivated land in the State, viz, experiments in making pastures at South Manchester, in which several hundred plats are devoted to grasses which have been "machine grazed" for ten years, and forestry experiments and investigations. In the latter work the State forester has begun a somewhat elaborate forest survey of the State, and has greatly enlarged the station forest-tree nursery at Poquonock preparatory to tree planting on a barren tract owned by the station. He reports that nearly 40 per cent of the area of the State is in forest, most of which, however, is poor in quality. While this area, properly managed, would be sufficient for the needs of the State, he recommends extending the forests to include certain waste land that could not be otherwise more profitably employed.

The station continues to do a very large amount of inspection work with fertilizers, foods, feeding stuffs, orchard pests, and dairy apparatus. During the winter the botanist resigned and was succeeded by G. P. Clinton, formerly of the Illinois Station. This station is cooperating with the Bureau of Plant Industry of this Department in testing novelties introduced by the seed trade, with the Bureau of Soils in tobacco investigations, and with the Bureau of Forestry in tree-planting experiments.

The Connecticut Station continues to receive approval of its work through the increase of its duties by the State legislature and the making of substantial appropriations of State funds for its uses. While obliged under State laws to perform a large amount of routine service, it has also been able to maintain its investigations of agricultural problems on a high plane of scientific efficiency.

LINES OF WORK.

The principal lines of work conducted at the Connecticut State Station during the past year were as follows: Analysis and inspection of fertilizers, foods, feeding stuffs; inspection of Babcock test apparatus and nurseries; chemistry—study of vegetable proteids; diseases of plants; horticulture—fertilization of orchards and study of the anatomy of fruits; forestry; field experiments—tobacco, grasses for turf making and pasture; and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$7,500.00
State appropriation	15,500.00
Individuals and communities	2,301.38
Fees	5,322.85
Farm products	1,241.00
Miscellaneous	52.46
Total	31,917.69

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 134–138 and the Annual Reports for 1900, Part IV, and 1901, Parts I, II, and III. The bulletins include information on insect pests, the growing of tobacco under shade, and commercial feeding stuffs. Part IV of the Annual Report for 1900 includes, among other things, papers on the following investigations in chemistry: A hydrolytic derivative of the globulin edestin and its relation to Weyl's albuminate and the histon group, the basic character of the protein molecule and the reactions of edestin with definite quantities of acids and alkalies, a type of reaction by which sodium carbonate and hydrochloric acid may be formed in the animal organism, and sulphur in protein bodies. Part I of the Annual Report for 1901 is devoted to fertilizers, Part II to food products, and Part III contains the first report of the State entomologist. The report on tobacco growing gives details, cost, advantages, and difficulties of growing tobacco under shade.

Storrs Agricultural Experiment Station, *Storrs.*[a]

Department of the Connecticut Agricultural College.

GOVERNING BOARD.

STATION STAFF.

L. A. Clinton, M. S., *Acting Director; Agriculturist.*
A. G. Gulley, M. S., *Horticulturist.*
W. O. Atwater, Ph. D., *Supervisor Nutrition Investigations* (*Middletown*).
H. W. Conn, Ph. D., *Supervisor Dairy Bacteriology* (*Middletown*).
C. L. Beach, B. S., *Dairy Husbandman.*
W. A. Stocking, jr., B. S. A., *Assistant Bacteriologist.*
F. H. Stoneburn, *Poultryman.*
H. L. Garrigus, B. Agr., *Assistant, Field Experiments.*
E. R. Bennett, B. S., *Assistant Horticulturist.*
W. M. Esten, M. S., *Laboratory Assistant* (*Middletown*).
B. F. Koons, Ph. D., *Consulting Entomologist.*
C. A. Meserve, Ph. D., *Consulting Chemist.*
E. H. Lehnert, B. S., D. V. S., *Consulting Veterinarian.*
E. A. White, *Consulting Botanist.*

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[a] Telegraph address, *Storrs via Willimantic;* railroad station, express, and freight address, *Eagleville.*

GENERAL OUTLOOK.

The work of the Connecticut Storrs Station during the past year has been confined mainly to inquiries in regard to the nutrition of plants, animals, and man, and the bacteriology of the dairy. In connection with the investigations relating to the nutrition of plants, the station has continued rotation tests for thirteen years to study the deficiencies of the soil and the needs of the different crops for the different ingredients of fertilizers. From the results obtained it appears that the fertilizing ingredients most needed have varied with the crop; that is to say, the peculiarities of the plant have had as much, or more, to do with deciding the demand for fertilizers than any special deficiency of the soil. Cowpeas and soy beans have been benefited by phosphoric acid and potash, but have paid little heed to nitrogen. Corn and oats have responded well to nitrogen, and both have been helped by phosphoric acid, but neither have been much increased by potash. Potatoes have been benefited by all three ingredients, and especially helped by potash. The results of the special nitrogen experiment with corn, cowpeas, and soy beans indicate that with the cereals the effect of the nitrogenous fertilizer is to increase both the total yield of the crop and the proportion of protein, while with the legumes the nitrogen of the fertilizers has very little effect upon either the yield or the composition. One of the most significant results of the bacteriological investigations is the suggestion that the lactic bacteria are rather an advantage than a disadvantage to the dairyman, since they protect the milk, cream, and cheese from the action of other bacteria. Investigations on the food and nutrition of man have, as heretofore, been aided by a special appropriation by the State, and are carried on at Middletown in connection with similar investigations conducted under the auspices of this Office (see page 58).

At the close of the fiscal year the station underwent reorganization. W. O. Atwater, who has been director of the station from the time of its organization in 1888, withdrew from the directorship, and L. A. Clinton, formerly of the New York Cornell Station, was appointed acting director. It is planned to confine the work mainly to field experiments with forage plants and other crops; dairying, including experiments and studies in dairy bacteriology; horticulture, and poultry investigations. The headquarters of this work will be at Storrs, but H. W. Conn, who will have supervision of the work in dairy bacteriology, will continue to reside in Middletown, as will also W. O. Atwater, who will continue his connection with the station as nutrition investigator and will have charge of the special fund of $1,800 appropriated by the State for nutrition investigations. The chemical work of the station will be transferred to Storrs as soon as practicable. It

is expected that laboratories for dairy bacteriology and for instruction and investigation in soil physics will be fitted up in the upper story of the dairy building at Storrs.

LINES OF WORK.

The principal lines of work conducted at the Connecticut Storrs Station during the past year were as follows: Food and nutrition of man and animals; bacteriology of dairy products; field experiments—fertilizers, soil tests, nitrogen experiments; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$7,500.00
State appropriation	1,800.00
Farm products	119.21
Total	9,419.21

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 23, the Annual Report for 1900, and a Supplement to the Annual Report for 1900, the latter containing a list of the publications of the Storrs Station since its origin in 1888. Bulletin 23 contains a paper on the relation of bovine tuberculosis to that of man and its significance in the dairy herd, and a report of the results of experiments with tuberculous cows and the use of their milk in feeding calves. The Annual Report for 1900 includes records and papers on the following subjects: Soil improvement, pot experiments with nitrogenous fertilizers, field experiments with fertilizers, contribution to the subject of the metabolism of matter and energy in man, analyses of fodders and feeding stuffs, rations fed to milch cows in Connecticut, sources of acid organisms concerned in the souring of milk, and a summary of results of experiments with tuberculous cows.

DELAWARE.

The Delaware College Agricultural Experiment Station, *Newark.*

Department of Delaware College.

GOVERNING BOARD.

Board of Trustees—Committee on Agriculture: James Hossinger, *Newark;* Manlove Hayes, *Dover;* W. F. Causey, *Milford;* W. H. Stevens, *Seaford.*

STATION STAFF

Arthur T. Neale, M. A., Ph. D., *Director; Agriculturist.*
F. D. Chester, M. S., *Mycologist.*
W. H. Bishop, B. S., *Meteorologist.*
C. P. Close, M. S., *Horticulturist.*
C. L. Penny, M. A., *Chemist.*
C. O. Houghton, *Entomologist.*

GENERAL OUTLOOK.

The work of the Delaware Station during the past year has been continued along lines previously established. Studies have been made and results published on the production and feeding of alfalfa, cowpeas, and crimson clover; on the Chinese cling group of peaches; orchard pests, and a number of diseases attacking fruits and vegetables. The bacteriologist has given some study to the bacteria concerned in transformations of nitrogen, and the horticulturist to methods of pruning and cover crops for orchards, the latter in cooperation with the Bureau of Plant Industry of this Department. Studies on the influence of environment on the sugar content of muskmelons have been conducted in cooperation with the Bureau of Chemistry. The entomologist resigned recently to accept a position in the Texas College and Station, and has been succeeded by C. O. Houghton, a recent graduate of Cornell University.

Difficulties of administration continue to be a hindrance to the progress of the Delaware Station. The college with which the station is connected needs land and other equipment to put its agricultural work on an efficient basis and to provide the station with facilities for field experiments such as the stations elsewhere have. The station is doing useful work and has the confidence and support of the farmers of the State, but might easily accomplish much more if it had additional financial aid from the State through the college.

LINES OF WORK.

The principal lines of work conducted at the Delaware Station during the past year were as follows: Chemistry; bacteriology—studies of nitrifying bacteria and nitrogen-assimilating bacteria; field experiments—culture experiments with legumes and other forage and field crops, breeding experiments with cereals; horticulture—study of cover crops for orchards, pruning of orchards, varieties of fruits; diseases of plants—study of blights and other diseases of cantaloupes, canker of pears and apples, asparagus rust and other fungus diseases of fruits and vegetables; feeding experiments; diseases of animals; entomology—studies of insects attacking fruit and shade trees; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation $15,000

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 53–55 on the following subjects: Three orchard pests—(1) the apple-bud borer, (2) the fruit-tree bark borer, and (3) the periodical cicada; the Chinese cling group of peaches; alfalfa, cowpeas, and crimson clover as factors in reducing feed bills; and a critical study of Getty's method of raising cowpeas for silage purposes.

FLORIDA.

Agricultural Experiment Station of Florida, *Lake City.*

Department of Florida Agricultural College.

GOVERNING BOARD.

STATION STAFF.

Thos. H. Taliaferro, C. E., Ph. D., *Director.*
H. K. Miller, M. S., *Chemist; Vice-Director.*
H. A. Gossard, M. S., *Entomologist.*
H. Harold Hume, M. S., *Botanist, Horticulturist.*
C. F. Dawson, M. S., D. V. S., *Veterinarian.*
C. M. Conner, B. S., *Agriculturist, Superintendent Farmers' Institutes.*
A. W. Blair, M. A., *Assistant Chemist.*
W. P. Jernigan, *Auditor, Bookkeeper.*
C. S. Brock, *Stenographer, Librarian.*
Lucia McCulloch, B. S., *Assistant Biologist, Assistant Librarian.*
L. de Gottrau, *Superintendent Citrus Experiments.*
John F. Mitchell, *Farm Foreman.*
J. H. Jefferies, *Foreman of Gardens and Orchards.*

GENERAL OUTLOOK.

The work of the Florida Station during the past year has been continued along lines of culture and fertilizer experiments with staple field and horticultural crops; the investigation of diseases and insect pests of the leading fruits and vegetables; and feeding experiments. There has been considerable cooperative work with farmers, especially along horticultural lines, including experiments in the growing and care of pineapples under shade at Jensen. There is also considerable

work in growing lettuce under muslin. The Bocaraton fruit plantation now contains about 320 trees of the orange, lemon, pomelo, and lime in a promising condition. The land used is representative of quite a tract not hitherto demonstrated to be suitable for citrus fruits. The plantation is conducted on an economic basis, and but few permanent improvements, aside from clearing and planting, are made. In cooperation with the Bureau of Plant Industry of this Department, the station is testing novelties introduced by the seed trade; and with the Bureau of Chemistry, is studying the available plant food in soils. Farmers' institute work has been successfully continued under the management of the agriculturist, with a State appropriation of $5,000 for two years. Veterinary work, under a similar State appropriation, has been successfully developed. The new Science Hall for the college and station is nearing completion. It is Spanish in design, consisting of a main building, three stories in height, and two wings at the rear, two stories in height, and will cost between $45,000 and $50,000. The farm, for which the last legislature appropriated $10,000, has been selected and some crops have been put out. It is located about half a mile from the college, and consists of about 100 acres, some of the soil being of very fair quality. The farm will be devoted largely to growing feed to be used in connection with feeding experiments. The agriculturist resigned recently and has been succeeded by C. M. Conner, formerly of the South Carolina Station.

The Florida Station has made considerable progress during the past year and is coming to have many warm friends among the fruit growers and progressive farmers of the State. The relatively large amount of cooperative work with farmers, the farmers' institutes, and the press bulletins which are now quite generally printed by the papers of the State have contributed to the cordial relations between the station and its constituents. These conditions and the vigorous way in which members of the staff are attacking some of the live problems in the State are very encouraging and make the outlook for useful work at this station better than ever before.

LINES OF WORK.

The principal lines of work conducted at the Florida Station during the past year were as follows: Chemistry—study of pineapple soils and of the food and fertilizer ingredients of pineapples; field experiments—cassava, corn, and other farm crops; horticulture—asparagus culture, blight of tomatoes, celery, and cantaloupes, varieties of strawberries and dewberries, studies of citrus fruits, experiments with lettuce and pineapples under cover; feeding experiments—with hogs, steers, and dairy animals; veterinary science; nature and causes of salt sickness; entomology—white fly, San José scale, pineapple insects, and pecan budworm.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,271.71
Total	16,271.71

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 56–60, and the Annual Report for 1901. The subjects of the bulletins are the cottony cushion scale, topworking pecans, pomelos, cauliflower, and velvet bean. Pomelos (shaddock or grape fruit) bear heavily in Florida, are no harder to propagate and care for than oranges and come into bearing earlier. The Annual Report contains reprints of Bulletins 56–68, brief reports by the horticulturist and entomologist, and papers on plant and food trials with sweet potatoes, sugar cane, potatoes, corn, cotton, and cassava, feeding experiments with steers and pigs, salt sickness, and notes on plant diseases.

GEORGIA.

Georgia Experiment Station, *Experiment.*[a]

Department of Georgia State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Directors: O. B. Stevens (*President*), *Atlanta;* J. B. Park, jr., *Greensboro;* Walter B. Hill, *Athens;* H. C. White, *Athens;* G. M. Ryals, *Savannah;* P. E. Boyd, *Leary;* J. T. Ferguson, *Leesburg;* J. H. Mobley, *Hamilton;* A. J. Smith, *Conyers;* N. B. Drewry, *Griffin;* Felix Corput, *Cavespring;* John Deadwyler, *Maysville;* George Gilmore, *Warthen;* William Henderson, *Ocilla.*

STATION STAFF.

R. J. Redding, *Director.*
H. C. White, C. E., Ph. D., *Vice-Director, Chemist.*
H. N. Starnes, B. A., *Biologist, Horticulturist.*
J. M. Kimbrough, *Agriculturist.*
Claude L. Willoughby, *Dairyman.*
Josephine M. Heyfron, *Stenographer, Accountant.*
C. A. Mosier, *Assistant Horticulturist.*

GENERAL OUTLOOK.

In addition to the work formerly conducted at the Georgia Station, several new lines of work have been undertaken. During the winter of 1901–2 forcing-house experiments were undertaken, and excellent

[a] Telegraph, express, and freight address, *Griffin.*

results were secured with cucumbers, tomatoes, radishes, lettuce, sweet-potato seedlings, etc. Pig-feeding experiments were inaugurated and will be given a prominent place in the investigations of the station, with a view of discovering some safe method of feeding cotton-seed meal to pigs. In the dairy department new steam heaters and improved machinery and implements have been added, and a study will be made of the economy of milk and butter production based largely on the use of home-grown feeds. It is planned to make quite a feature of field experiments with celery and to investigate methods of keeping sweet and Irish potatoes. Considerable work with cantaloupes has been undertaken, and the cooperation of farmers in three different sec tions of the State has been secured. Considerable more work of a cooperative nature might be undertaken, and it is likely that the influence of the station could in this way be considerably extended. The station is cooperating with this Office in nutrition investigations. The biologist and horticulturist resigned recently to accept a position in this Department, and has been succeeded by H. M. Starnes, formerly of the Georgia State College of Agriculture and Mechanic Arts.

The Georgia Station continues to do a considerable amount of useful work. It needs, however, the further aid of the State to enable it to conduct investigations which will be of direct benefit to different agricultural regions and which will promote more extensively the interests of such industries as dairying and horticulture. The State also needs an efficient system of farmers' institutes, through which the results of station work may be more widely and efficiently disseminated among the farmers.

LINES OF WORK.

The principal lines of work conducted at the Georgia Station during the past year were as follows: Field experiments; horticulture—orchard and small fruits, celery, cantaloupes, forcing vegetables; entomology; pig feeding; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	740.25
Farm products	2,263.26
Balance July 1, 1901	2,498.49
Total	20,502.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 53–56 and the Annual Report for 1801. The bulletins include reports on cotton culture, corn culture, grapes, and a study of the pickle worm (*Margaronia nitidalis*), its life history, and means for suppressing it.

HAWAII.

Hawaii Agricultural Experiment Station, *Honolulu.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

Jared G. Smith, *Special Agent in Charge.*
T. F. Sedgwick, *Agriculturist.*
D. L. Van Dine, *Entomologist.*
Frank E. Conter, *Farm Foreman.*

GENERAL OUTLOOK.

During the past fiscal year an endeavor was made to put the Hawaii Agricultural Experiment Station on a working basis. The first half of the year was devoted to the completion of buildings and to making other permanent improvements, such as grading, road making, and preparing land for experimental work. The station buildings now include a residence for the special agent in charge, an office and a laboratory, stable, cottages for laborers, water tanks, and a muslin-covered plant house. A small two-room cottage has been built on the upper part of the station grounds for the care taker there, adjacent to which is a 3,000-gallon tank for storing water collected from the roof of the cottage.

The experiments and investigations undertaken were concerned in the solution of some of the most pressing agricultural problems of the islands. The suppression of insect pests and fungus diseases of plants was given much attention. Taro, the staple food of the native Hawaiians, is attacked by a serious root rot, which yielded partially to improved soil conditions resulting from the application of lime and complete fertilizers. Experiments with potatoes were conducted on the island of Maui in cooperation with one of the residents of that island. Potatoes are attacked by two diseases, one of which yields to treatment with Bordeaux mixture. The other disease, a black wilt, did not yield to this treatment, but tests of 45 varieties of potatoes resulted in finding one resistant and two partially resistant varieties. Field experiments with cotton, hemp, and sorghum have been undertaken, and work in improving ranges and in growing alfalfa and other forage crops has been planned. Among the most destructive insects

are the cane borer, melon fly, poka worm, and Japanese beetle. These have been studied and will be subjects of further investigation. Quite a little equipment for the entomological work has been secured, including works of reference, microscopes, spray pumps, and other apparatus. Investigations on the diseases of poultry were begun, and a bulletin was issued in which suggestions were given for the care of fowls and the treatment of diseases to which they are especially subject and as a result of which poultry and eggs are excessively expensive in the Hawaiian markets.

The station has made chemical and technical examinations of drugs, liquors, cereal products, and textile fabrics for the collector of customs and the collector of internal revenue. Forest nursery work on a small scale has been undertaken on the station farm for the War Department to furnish trees for planting on the new military post near Honolulu. A preliminary study of the coffee industry has been made with a view to extending coffee growing in the Territory, and some time has been given to an inquiry into the cost of irrigating on sugar plantations. A station library has been started with 2,000 books and pamphlets donated by the special agent in charge as a nucleus. Some material for a herbarium has also been collected. Farmers' institutes have been organized under the auspices of the officers of the station, and four successful meetings have been held. In some places local institute societies have been formed, which hold monthly meetings.

There is a wide field for investigation in the insular agriculture in this Territory. The problems are very different from those on the mainland and vary greatly on the different islands constituting the group. On account of these differences individual investigation on such subjects as the testing of varieties and the introduction of new crops have little more than local significance. The Hawaii Station is rapidly putting itself in touch with many of the various agricultural interests and will soon be in a position to render much useful assistance to its constituents.

LINES OF WORK.

The principal lines of work conducted at the Hawaii Station during the past year were as follows: Field experiments—varieties of cotton, hemp, sorghum, potatoes, taro, culture experiments; horticulture—experiments with strawberries, growing of grape cuttings; diseases of plants and animals—fusarium diseases of potatoes, taro rot, diseases of poultry; entomology—study of injurious insects and means for their repression.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$12,000

PUBLICATIONS.

The publication of this station received during the past fiscal year was Bulletin 1, on chickens and their diseases in Hawaii. The second report on the investigations in Hawaii, giving a detailed account of the operations during the year 1902, has been prepared by the special agent in charge of the Hawaii Station and is given on page 309.

Hawaiian Sugar Planters' Experiment Station, *Honolulu.*

GOVERNING BOARD.

Board of Trustees: W. G. Irwin, H. A. Isenberg, W. O. Smith, G. H. Robertson, F. A. Shaefer, H. P. Baldwin, J. B. Atherton, F. M. Swanzy, B. F. Dillingham.

STATION STAFF.

C. F. Eckart, *Director; Chief Chemist.*
S. S. Peck, B. S., *First Assistant Chemist.*
F. R. Werthmueller, B. S., *Second Assistant Chemist.*
E. G. Clarke, *Field Assistant*

GENERAL OUTLOOK.

The work of this station during the past year has been continued along the same lines as formerly, the aim of the investigations being to improve both the technical and the cultural branches of the sugar industry in the Hawaiian Islands. The institution possesses a commodius chemical laboratory, in which are conducted experiments bearing on the manufacture of sugar and the analysis of sugar-house products, soils, fertilizers, and irrigation waters. The field work has included irrigation, variety tests of cane, fertilizer experiments, and other cultural investigations bearing on the economic limitations of intensive agriculture.

IDAHO.

Agricultural Experiment Station of the University of Idaho, *Moscow*

Department of the University of Idaho.

GOVERNING BOARD.

Board of Regents: John B. Goode (*President*), *Rathdrum;* Mrs. Wm. H. Ridenbaugh (*Vice-President*), *Boise;* George C. Parkinson (*Secretary*), *Preston;* George W. Chapin, *Idaho Falls;* Henry E. Wallace, *Caldwell;* Wm. L. Payne (*Treasurer*), *Moscow.*

STATION STAFF.

Hiram T. French, M. S., *Director; Agriculturist.*
Louis F. Henderson, Ph. B., *Botanist.*
John M. Aldrich, M. S., *Entomologist.*
John E. Bonebright, M. A., *Meteorologist.*
Chas. N. Little, M. A., Ph. D., *Irrigation Engineer.*
Henry B. Slade, B. A., *Chemist.*
L. B. Judson, *Horticulturist.*
Herbert T. Condon, *Clerk.*
Wm. L. Payne, *Treasurer.*

GENERAL OUTLOOK.

The work of the Idaho Station has changed but little during the past year. One of its leading objects is to introduce animal production more generally as a substitute for continuous grain growing throughout the State. With this object in view, experiments in the feeding of cattle, sheep, and swine have been continued and broadened somewhat, as have also the experiments with various grasses and forage plants for pasture and hay. At the same time considerable attention has been given to work with cereals, the diseases and insect enemies of different fruits and vegetables, and to horticultural work. The horticultural possibilities of the State are great, and there is need of more extensive investigations in this line. The station is cooperating with the Bureau of Plant Industry of this Department in testing novelties introduced by the seed trade, with the Bureau of Soils in a soil survey, and with a number of farmers in sugar-beet experiments. Farmers' institutes, under the management of the board of regents of the university and the superintendency of the agriculturist, were held at about fifty places in the State during the past year. They are supported by a State appropriation of $1,000 a year for two years, and have been instrumental in creating considerable interest in the work of the university and experiment station. An effort will be made to organize the institute work so that each locality will have a permanent organization under whose auspices institutes will be held. The horticulturist of the station left December 31, 1902, to engage in fruit growing as a private enterprise, and has been succeeded by L. B. Judson, of Michigan.

The Idaho Station has made considerable progress in differentiating station from university work and in providing special officers and definite assignments of time for station work. The chemist of the university and station has been assigned exclusively to university work, and H. B. Slade has been appointed chemist of the station without teaching duties. By combining the departments of botany and zoology in the university into a department of biology more time has been secured for station investigations by the officers in charge of these departments. At the June meeting of the board of regents a resolution was adopted to separate the office of president of the university and director of the station as soon as the funds of the university will permit. In accordance with this resolution Hiram T. French, agriculturist of the station, has recently been appointed director. These changes and the support given by the State for farmers' institute work are encouraging for the future growth and increased usefulness of the station.

LINES OF WORK.

The principal lines of work conducted at the Idaho Station during the past year were as follows: Chemistry—experiments with sugar beets, studies of wheats and wheat soils, miscellaneous analytical work; botany—studies of plant diseases and their remedies, experiments with grasses and forage crops; field experiments—tests of various grasses and other forage crops for pasture and hay, experiments with cereals desirable for introduction; horticulture—culture and variety tests of garden crops, fruits, and forest trees, pruning experiments, and experiments with tomatoes; entomology—study of the codling moth in cooperation with entomologists of other northwestern stations, observations on phylloxera, and experiments with insecticides; feeding experiments—cattle, sheep, and swine.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,000.00
Farm products	965.75
Total	16,965.75

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 28–31 and the Annual Report for 1901. Bulletin 29 is the report of the director of the station for the two years ended June 30, 1900. One bulletin contains meteorological records, two are devoted to soil investigations, and one to spraying experiments.

ILLINOIS.

Agricultural Experiment Station of the University of Illinois, *Urbana.*

Department of the University of Illinois.

GOVERNING BOARD.

STATION STAFF.

Eugene Davenport, M. Agr., *Director.*
T. J. Burrill, Ph. D., *Botanist.*
S. A. Forbes, Ph. D., *Entomologist.*
D. McIntosh, V. S., *Veterinarian.*
C. G. Hopkins, Ph. D., *Agronomist, Chemist.*
J. C. Blair, *Chief in Horticulture.*
H. W. Mumford, B. S., *Animal Husbandman.*
W. J. Fraser, M. S., *Dairying.*
L. H. Smith, B. S., *Chemist.*
J. W. Lloyd, B. S. A., *Chief Assistant in Horticulture.*
A. D. Shamel,[a] B. S., *Chief Assistant in Farm Crops.*
A. J. Glover, B. Agr., *Chief Assistant in Dairy Husbandry.*
J. G. Mosier, B. S., *Chief Assistant in Soil Physics.*
C. F. Hottes, Ph. D., *Assistant in Botany.*
E. B. Forbes, B. S., *Animal Husbandman.*
C. S. Crandall, B. S., *Chief Assistant in Pomology.*
H. Hasselbring, B. S., *Assistant in Vegetable Pathology.*
J. H. Petitt, Ph. B., *Assistant in Chemistry.*
E. M. East, B. S., *Assistant in Chemistry.*
W. F. Pate, B. S., *Assistant in Chemistry.*
Kate McIntyre, *Secretary.*

GENERAL OUTLOOK.

At the Illinois Station during the past year old lines of work have been continued and great progress has also been made in the development of extensive investigations provided for by special State appropriations. In the department of agronomy the selection of corn for special chemical constituents has already given important results, leading to the organization of a corn-breeders' association, with which the station is cooperating, and to the chartering of companies for the commercial production of seed corn. This work has been continued and extensive investigations with soils, partly in cooperation with the Bureau of Soils of this Department, have been undertaken. Inoculation experiments with Illinois soils gave excellent results in the production of alfalfa. The study of dairy conditions in the State has shown the need of improvements in this industry. Demonstrations of improved methods will therefore be undertaken on a larger scale and with special reference to the conditions actually existing in the State as brought out by the studies thus far made by the station. An extensive study of the grading of beef cattle as practiced at the Chicago stock yards has been completed and the results published in Bulletin 78. It has been shown that the grades actually used differ from those commonly published in market returns. There is, therefore, need of fixing standards that will be followed by the purchasers of live stock and the publishers of market returns, so that both buyer and seller will have an accurate basis for judging cattle. It is hoped that the bulletin already published will do much toward accomplishing this end. An effort will be made also to secure more uniform standards for selling meats, and an experiment will be undertaken in feeding carloads of cattle selected according to the grades established by the station and selling them to determine which grade will give the most

[a] On leave.

profitable gains on the same ration. Feeding experiments with pigs indicate that for the production of bacon more depends on the diet than on the breed.

The study of bitter rot of apples has led to important practical results. It has been determined that bitter rot may be transmitted from cankers formed on the trees. These are also the principal means of carrying the disease over from year to year, but they may be easily cut out and destroyed. Spraying, if properly done early in the season, will also reduce the rot materially. Studies of the second brood of the codling moth have shown that late sprayings for this insect are useful. C. S. Crandall, formerly of the Colorado Station, has been elected chief assistant in pomology and is giving particular attention to studies of the apple. Cold-storage experiments are a feature of the work.

The station is cooperating with the Bureau of Soils of this Department in a soil survey, with the Bureau of Plant Industry in growing sugar-beet seed and making tests of novelties introduced by the seed trade, and with the Bureau of Chemistry in studying the available plant food in soils. Cooperation with farmers and others in the State is becoming an important part of the station work. A detailed account of these cooperative enterprises is given on page 508. The new building for the department of chemistry of the university, which is nearing completion, contains a special laboratory for the nutrition investigations carried on in cooperation with this Office, which are attracting favorable attention at the university.

The Illinois Station is proceeding on the policy of investigating the agricultural conditions in the State in order that efforts may then be made to correct unwise methods and improve conditions. The people of the State have been taken fully into the confidence of the station and have expressed their approval of its plans by providing generous sums for special investigations in a few leading agricultural industries. The efforts of the past year have been devoted largely to the inauguration of this work. The college with which the station is connected is developing courses in several of the branches of agricultural science. It is now offering several courses in farm mechanics. It is also developing extension work in agriculture and has been instrumental in the organization of a number of young people's clubs, with the members of which cooperative work of some educational value is arranged.

LINES OF WORK.

The principal lines of work conducted at the Illinois Station during the past year were as follows: Chemistry—methods of determining sugar content of beets; studies of the chemical composition of corn; bacteriology; pot and field experiments—pot experiments with type soils from different parts of the State, studies on management of soils conducted on type soils in fifteen or sixteen different regions, inoculation

experiments with alfalfa, experiments with sugar beets; horticulture—experiments in orchard management, renovation of orchards, cold-storage investigations, experiments with garden vegetables; forestry; plant breeding—experiments in breeding and selecting corn to change the protein, oil, and starch contents; animal husbandry—studies of dairy conditions in different parts of the State, study of methods of grading beef cattle in Chicago markets, feeding experiments with pigs; diseases of plants—study of bitter rot and other rots of apples, apple scabs and cankers; diseases of animals; entomology; and dairying.

INCOME.

The income of the station during the past fiscal was as follows:

United States appropriation	$15,000.00
State appropriation	54,000.00
Fees	600.00
Farm products	246.92
Balance from previous year	865.24
Total	70,712.16

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were: Bulletins 66–72, and the Annual Report for 1901. The bulletins are on the following subjects: Individual differences in the value of dairy cows, apple scab, important details of spraying, apple rots in Illinois, canker of apple trees, experiments with insecticides for the San José scale, additional insecticide experiments for the San José scale. The Annual Report for 1901 includes brief reports from the different departments.

INDIANA.

Agricultural Experiment Station of Indiana, *Lafayette.*

Department of Purdue University.

GOVERNING BOARD.

STATION STAFF.

Henry A. Huston, M. A., A. C., *Director.*
Wm. C. Latta, M. S., *Agriculturist.*
James Troop, M. S., *Horticulturist.*
J. C. Arthur, D. S., *Botanist.*
A. W. Bitting, D. V. M., *Veterinarian.*
J. H. Skinner, B. S., *Animal Husbandman.*
A. T. Wiancko, B. S. A., *in Charge of Field Experiments.*
Wm. J. Jones, M. S., A. C., *Assistant State Chemist.*
H. E. Van Norman, B. S., *Dairying.*
R. M. Hamer, *Stockman.*

GENERAL OUTLOOK.

The experimental work of the Indiana Station has proceeded along much the same lines as heretofore, including not only the ordinary station enterprises, but also investigations in cooperation with this Department as follows: With the Bureau of Plant Industry, in tests of novelties introduced by the seed trade; with the Bureau of Chemistry, in sugar-beet investigations, studies of the influence of environment on the sugar content of muskmelons, and of the gluten content of wheat, and with the Bureau of Soils in a soil survey. The veterinarian has published the results of his studies on the physiology of milk secretion, and is preparing to publish the results of work covering several years on sheep diseases. Feeding experiments with pigs in which tankage formed a part of the diet in comparison with corn showed better results for the former.

Both the college and the station are undergoing reorganization, owing to the resignation of the director and several other members of the staff and to the erection of a new agricultural building for the college and station. The director resigned to accept the professorship of animal husbandry in the Ohio State University and was succeeded by the chemist of the Indiana Station. The new building is nearing completion and will include class rooms, laboratories, and an assembly hall for large meetings. (Pl. I, fig. 1.) The work of the station in dairying and soils will be transferred to this building, thus giving more room and better facilities for the station enterprises left in the old building. A new heating plant for the university and station has been installed at a cost of about $6,000, the latter incurring part of the expense in consideration of having heat furnished hereafter without charge from the university. The university is displaying toward the station a more liberal policy, which, if continued according to present plans, should result in greatly increased efficiency along investigational lines. Farmers' institutes have been held as heretofore, but with additional funds, which permit of considerable expansion of the work. Interest in short courses in agriculture is increasing.

LINES OF WORK.

The principal lines of work conducted at the Indiana Station during the past year were as follows: Chemistry—studies of sugar beets, the

nitrogen-free extracts of feeding stuffs, fertilizer experiments with tomatoes, study of losses in curing and keeping corn fodder in the field; pot and field experiments—cultural and fertilizer experiments with cereals and forage crops, rotations, pot experiments with legumes and cereals to test the efficiency of soil inoculation; horticulture—cross fertilization of apples, variety tests of fruits and vegetables; feeding experiments—comparison of tankage and other feeds for swine, feeding dairy cows; diseases of plants and animals—studies of milk fever, diseases of sheep, the physiology of milk secretion, sanitary milk inspection, treatment of wheat for smut, edible fungi, etc.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	3,306.48
Total	18,306.48

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 88–92 and the Annual Report for 1901. The bulletins include reports on systems of cropping with and without fertilizers, the source of milk supply for towns and cities, tankage as a food for pigs, the modern silo, fertilizer tests on tomatoes. The Annual Report, in addition to a brief account of the work of the station by the director, contains papers on the following subjects: An edible fungus, effect of renewing the humus in continuous corn culture, the sugar beet in Indiana, indoor tomato culture with commercial fertilizers, the horse nettle and buffalo bur, and the physiology of milk secretion.

IOWA.

Iowa Agricultural Experiment Station, *Ames.*

Department of Iowa State College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

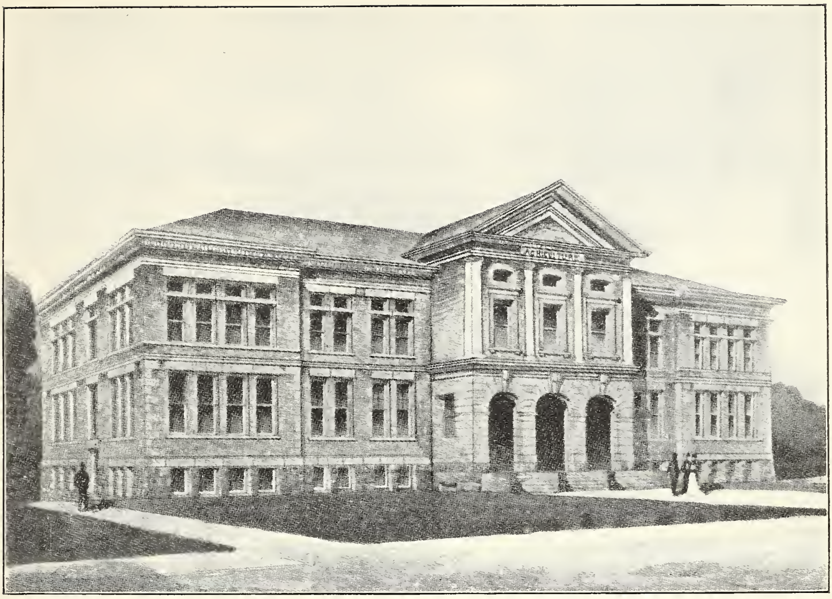

FIG. 1.—INDIANA COLLEGE AND STATION—AGRICULTURAL BUILDING.

FIG. 2.—IOWA STATION—NEW BARN.

STATION STAFF.

C. F. Curtiss, M. S. A., *Director; Agriculturist.*
J. B. Weems, B. S., Ph. D., *Agricultural Chemist.*
L. H. Pammel, B. Agr., M. S., Ph. D., *Botanist.*
H. E. Summers, B. S., *Entomologist.*
W. J. Kennedy, B. S. A., *Vice-Director; Animal Husbandman.*
P. G. Holden, M. S., B. Pd., *Agronomist.*
John J. Repp, V. M. D., *Veterinarian.*
Alfred Atkinson, *Assistant Agronomist.*
Jos. E. Guthrie, M. Sc., *Assistant Entomologist.*
E. C. Myers, B. S. A., *Assistant Agricultural Chemist.*
G. L. McKay, *Dairying.*
Homer C. Price, M. S. A., *Horticulturist.*
F. R. Marshall, B. S. A., *Assistant in Animal Husbandry.*
C. M. King, *Assistant Botanist; Artist.*
E. E. Little, M. S. A., *Assistant in Horticulture.*
A. T. Erwin, M. S. A., *Assistant Horticulturist.*
A. Estella Paddock, B. S., *Assistant Botanist.*
W. H. Stevensen, B. A., *Assistant in Soils.*
W. H. Olin, M. S. A., *Assistant in Agronomy.*
F. W. Bouska, B. S. A., *Assistant in Dairying and Dairy Bacteriology.*
C. Larson, B. S. A., *Assistant in Dairying.*

GENERAL OUTLOOK.

Investigations in animal husbandry have been leading features of the work of the Iowa Station during the past year. The work in agronomy and dairying has not been pushed so actively as heretofore, owing to lack of assistance and equipment in these departments. The investigations in animal husbandry have included both breeding and feeding experiments with horses, cattle, sheep, and swine. The station has been able to arrange for cooperation with large cattle feeders on favorable terms in feeding cattle in carload lots. One such experiment at Odebolt on 220 head of cattle fattened for the Chicago market attracted wide attention and gave important practical results regarding the comparative value of certain condimental feeds, dried blood, and the by-products of corn, flaxseed, and cotton seed when fed in conjunction with corn. The feeding experiments with pigs have included comparative tests of corn and beef meal and the various kinds of tankage prepared for sale by packing houses. The horticultural work has also been important and has included, in addition to the station operations, cooperation with members of the State Horticultural Society in the cross pollination of apples. The entomologist has published his work on the Aphididæ of North America. The work of the botanist on the grasses of the State in cooperation with the State geological survey, with the assistance of the station chemist and the Agrostologist of this Department, has been concluded and part of the results have been published in a report of over 500 pages as Bulletin 1 of the survey. The station is cooperating with the Bureau of Plant Industry of this Department in cereal investigations and tests of novelties introduced by the seed trade, with the Bureau of Animal Industry in efforts to breed a type of sheep better suited to range conditions, with the Bureau of

Chemistry in studying the available plant food in soils, and with the Bureau of Soils in a soil survey. The sugar-beet investigations in cooperation with the Bureau of Chemistry have been continued to a certain extent, but it has been practically demonstrated that a large part of the State is well adapted to the production of sugar beets. Officers of the station staff assist very little in farmers' institutes, which are held under local county management.

The last general assembly of the State gave the college and station $135,000 for maintenance and improvements for the biennial period (including $10,000 annually for maintenance of the station, $5,000 for the purchase of pure-bred stock, and $5,000 toward the construction of a station barn) and voted the college a one-fifth mill levy for five years, from which the station will receive material benefits. It is expected that this levy will yield about $600,000, from which liberal sums will be taken for building purposes. The main college building, the remainder of which was destroyed by fire last August, will be replaced by a new main building which, when completed, will contain headquarters for the agricultural department of the college and the experiment station. During the past year a horticultural building with a greenhouse has been completed at a cost of about $6,000. This provides facilities for studying the keeping qualities of fruits in cold storage and some other experimental work. A brick station barn (Pl. I, fig. 2) has been erected at a cost of about $17,000. This barn is 100 by 50 feet, with a wing 36 by 12 feet, and a silo 28 feet in diameter. The second floor is to be devoted to work in agronomy and the remainder to stalls for cattle and horses and to storage for feed. A Chicago firm recently presented to the station 50 head of pure-bred and high-grade Galloway heifers for use in breeding and feeding experiments to test the beef value of the blue-gray Shorthorn-Galloway cross so popular in England. The president of the college, W. M. Beardshear, died August 5, 1902, and his successor has not yet been chosen. During the past year the assistant agriculturist resigned to engage in agricultural journalism, and at the beginning of the present year P. G. Holden, of Illinois, was elected agronomist of the station and vice-dean of agriculture in the college. The animal husbandman, W. J. Kennedy, has recently been made vice-director. Assistants have been appointed in agronomy and dairying.

Animal husbandry, agronomy, and horticulture are of great importance in Iowa. In animal husbandry and horticulture the station now has excellent equipment and well-organized work is in progress. It is in close touch with the leading farmers in the State, and the results of its investigations, especially those in stock feeding, are closely watched. The recent liberal State appropriations will enable it to improve its equipment for work in agronomy and other lines, and with its present strong organization the station is in position to develop work of great importance to the agriculture of the State.

LINES OF WORK.

The principal lines of work conducted at the Iowa Station during the past year were as follows: Chemistry—studies of adulterants of dairy products, examination of grasses, soils, waters, and dairy products; botany—study of grasses of the State, forestry problems, etc.; field experiments—cultural and breeding experiments with corn, wheat, and other cereals, flax, legumes, sorghum, teosinte, millet, Kafir corn, sugar beets, carrots, and potatoes; horticulture—crossing of fruits, tests of cover crops, cross pollination of apples in different parts of the State, culture and variety tests of celery, tests of ornamentals, top-working of apples on crab stocks; diseases of plants; animal husbandry—feeding experiments with cattle and sheep in carload lots, and with horses and swine, comparison of proprietary feeds, gluten feed and meal, and corn; breeding range sheep and horses; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	4,304.61
Miscellaneous, including fees	33.51
Total	19,338.12

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 56 and 59–64, and the Biennial Report for 1900–1901. The investigations reported in the bulletins include the following: Pastures and meadows of Iowa; a bacteriological study of the college creamery milk supply; a case of putrid butter; purification of milk by the centrifugal separator; the Aphididæ of North America; a study on the germination and growth of Leguminosæ, especially with reference to large and small seed; sheep feeding experiments; and notes on strawberries.

KANSAS.

Kansas Agricultural Experiment Station, *Manhattan.*

Department of Kansas State Agricultural College.

GOVERNING BOARD.

Board of Regents: J. S. McDowell (*President*), *Smith Center;* F. D. Coburn (*Vice-President*), *Kansas City;* E. T. Fairchild (*Treasurer*), *Ellsworth;* William Hunter (*Loan Commissioner*), *Blue Rapids;* J. M. Satterthwaite, *Douglass;* S. J. Stewart, *Humboldt;* E. R. Nichols (*Secretary ex officio*), *Manhattan.*

STATION STAFF.

J. T. Willard, M. S., *Director; Chemist.*
E. A. Popenoe, M. A., *Entomologist.*
H. F. Roberts, M. S., *Botanist.*
D. H. Otis, M. S., *Animal Husbandman.*
N. S. Mayo, M. S., D. V. S., *Veterinarian.*
Albert Dickens, M. S., *Horticulturist.*
A. M. Ten Eyck, M. S., *Agriculturist.*
E. H. Webster, M. S., *Dairying.*
L. F. Paull, M. A., *Assistant Botanist.*
J. G. Haney, M. S., *Superintendent Fort Hays Branch Experiment Station, Hays.*
Lorena E. Clemons, B. S., *Secretary.*
C. L. Barnes, D. V. S., *Assistant in Veterinary Department.*
George A. Dean, M. S., *Assistant Entomologist.*
V. M. Shoesmith, B. S., *Assistant in Feeding and Field Work.*
R. H. Shaw, B. S., *Assistant Chemist.*
G. O. Greene, M. S., *Assistant Horticulturist.*
Alice M. Melton, B. S., *Clerk to Director.*

GENERAL OUTLOOK.

At the Kansas Station during the past year much attention has been given to the growing and feeding of drought-resistant crops, to correlated soil investigations, and to the improvement of cereals. During the severe drought moisture determinations made in soils upon which a variety of crops were growing gave an insight into the relative drought-resisting power of the crops. The principal work in the improvement of cereals was a continuation of experiments to increase the protein content of corn. In the horticultural department new plantings of fruit were made and a large vineyard and an orchard of 40 acres were leased for the purpose of making investigations on a commercial scale. The work of selecting and improving native fruits was continued, and in addition to the investigations with the plum and grape, similar work was undertaken with the papaw, persimmon, wild currant, and wild gooseberry. The veterinarian has been investigating the cause and method of transmission of infectious sore mouth in cattle, and has studied the life history of the fringed tapeworm of the sheep, besides making observations on poisoning of stock by the eating of weeds. Numerous experiments have been made also to determine the number of bacteria in the soil at different depths and under different methods of cultivation. Cooperation with the Bureau of Plant Industry of this Department in testing novelties introduced by the seed trade, in cereal investigations, and in improving pastures and ranges has been continued. In cooperation with the Bureau of Chemistry the station is investigating the available plant food in soils.

Under a recent provision of the State legislature the station has undertaken investigations in the destruction of prairie dogs and gophers. Various means of destruction have been tested and a poison containing potassium cyanid and strychnine has been adopted as most effective and is furnished to township trustees and others at cost. The new $70,000 building for the department of physics and chemistry of the college is nearly completed. It will also provide ample quarters for the chemist of the experiment station and will allow the dairy

barn, in which the chemical department has been housed for the past two years, to be used for its legitimate purposes.

The station has now come into full possession of that part of the Fort Hays Reservation set apart for its use and has undertaken some experiments there with forage crops and cereals to test them under semi-arid conditions. At the close of the fiscal year the agriculturist of the station retired to assume the superintendency of a large farm, and the position has been filled recently by the election of A. M. Ten Eyck, formerly of North Dakota. Farmers' institutes have been conducted as heretofore under the supervision of the dairy husbandman with a State appropriation of $2,000. About 100 institutes were held and 20 members of the college and station staff devoted on an average fifteen days each to the work. Of those who engaged in the work 15 were members of the station staff.

With the growth of the general business of the station, increase of the number of students in the college, and development of the farmers' institute work, the demands upon station officers for work of different kinds have increased until they constitute a hindrance to the planning and execution of the most thorough agricultural investigations. The frequent changes in the staff have also been detrimental to the station. For these reasons the Kansas Station, while accomplishing considerable useful work, needs further financial aid from the State and the maintenance of a more consistent and liberal policy of administration to put its affairs on the most efficient basis. It is very important that this station should have a number of experts who can give their time fully to the work of investigation without being interrupted by frequent calls for other services.

LINES OF WORK.

The principal lines of work conducted at the Kansas Station during the past year were as follows: Soils—moisture determinations, bacteriological investigations; horticulture—orchard and vineyard experiments on a commercial scale, selecting and improving native fruits; plant breeding—to increase protein content of corn; field experiments—growing drought-resistant crops, variety tests of grasses; feeding and digestion experiments—maintenance ration, experiment with wheat and wheat straw, feeding calves; diseases of animals—infectious sore mouth of cattle, cattle distemper, poisoning from weeds; entomology; dairying; and extermination of prairie dogs and gophers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,351.68
Balance on hand July 1, 1901	800.96
Total	17,152.64

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 102–109 and the Annual Report for 1901. The subjects upon which bulletins have been published are forage plants for Kansas, digestion experiments with Kansas feeds, fall seeding of alfalfa, blackleg in Kansas, the experimental apple orchard, analyses of corn with reference to its improvement, the hardy catalpa, spontaneous combustion of alfalfa. The investigations with catalpa trees were begun on the college grounds in 1872. The results of these investigations and of the commercial enterprises in growing catalpa forests in Kansas are published in the bulletin on The Hardy Catalpa. "The catalpa plantings made by the college and the experiment station have given encouraging results." Even on very poor soil the catalpa has been a paying crop and at the same time has been beneficial by preventing washings and by the addition of some humus. On good soil the results have been proportionately better. The results on the commercial plantations have varied with local conditions and the care given to the trees. Careful estimates based on a plantation of 500 acres where the best of conditions prevailed "give total cost of growing and marketing timber on one acre for 10 years as $51.70; gross value of product in 10 years, $267.15; net profit, $215.45; net profit, less 6 per cent compound interest on expenditures, $197.55 per acre; net annual profit for first 10 years, $19.75; owner's estimate of present gross value of product (3 years later than above valuation) $400 per acre; annual income of plantation at present, as estimated by owner, $50 per acre."

KENTUCKY.

Kentucky Agricultural Experiment Station, *Lexington.*

Department of the Agricultural and Mechanical College of Kentucky.

GOVERNING BOARD.

Board of Control: C. M. Clay, jr., (*Chairman*), *Paris;* R. S. Bullock, (*Treasurer*), *Lexington;* J. K. Patterson, *Lexington;* M. A. Scovell, (*Secretary*), *Lexington;* D. F. Frazee, *Lexington;* George B. Kinkead, *Jackson;* J. B. Kennedy, *Paris.*

STATION STAFF.

M. A. Scovell, M. S., *Director; Chemist.*
A. M. Peter, M. S., *Chemist.*
H. E. Curtis, M. S., *Chemist.*
Harrison Garman, *Entomologist, Botanist.*
J. N. Harper, B. S., *Agriculturist.*
J. O. La Bach, M. S., *Chemist.*
W. H. Scherffius, B. S., *Assistant Chemist.*
J. W. Nutter, *Assistant Dairyman.*
O. M. Shedd, *Assistant Chemist.*
George Roberts, M. S., *Assistant Chemist.*
S. D. Averitt, M. S., *Assistant Chemist.*
E. P. Taylor, *Assistant Entomologist and Botanist.*
D. W. May, M. S., *Animal Husbandman.*
J. D. Turner, B. Ped., *Secretary to Director.*
R. M. Allen, B. A., *Clerk.*
M. L. Didlake, M. S., *Assistant Entomologist and Botanist.*

GENERAL OUTLOOK.

The work of the Kentucky Station during the past year, while devoted to some features of general interest, has been especially directed along the lines of interest to the farmers of the State. Problems in stock breeding, the value of certain local feeds, and the study of hemp and tobacco may be mentioned as special subjects of investigation. Studies have been made of the fertilization, cultivation, and curing of White Burley tobacco; the adaptability of certain soils for the growing of cigar tobaccos, both wrapper and filler; fertilization and methods of curing hemp; the development of a cowpea producing abundant seed in the latitude of the station; breeding wheat and sorghum; the bacteria of legumes; the use of poisons on cabbage; the insect pests and fungus diseases of forage plants, grapes, and cereals; the adaptability of certain local feeds for pigs; the feeding of dairy cattle and studies of the so-called cornstalk disease of cattle. In the feeding experiments with pigs, distillery waste was not found valuable, but corn fed with soy beans proved excellent. The station will take up the question of beef production with Shorthorns, which should lead to important results.

The station is cooperating with the Bureau of Plant Industry of this Department in studying methods of establishing and maintaining permanent pastures, the influence of origin of red-clover seed on yield of clover, rotation of crops, farm management, tests of novelties introduced by the seed trade, and with the Bureau of Chemistry on sugar-beet investigations, investigations of the gluten content of wheat, and studies of available plant food in soils and of the influence of environment on the sugar content of muskmelons.

The increased income of the Kentucky Station has enabled it to extend its facilities and make many improvements. Several new buildings, including a dairy barn and a piggery, are being erected. The governing board at a recent meeting authorized the erection of a $20,000 office and laboratory building for the station on a piece of ground recently purchased for $4,000 and lying between the college campus and the station farm. The station will also be able to deal

more effectively with problems affecting the chief agricultural interests of the State. It has the advantage of a staff which, for the most part, devote their attention exclusively to station work. By cooperating with the State commissioner of agriculture in the farmers' institutes held in the different parts of the State, the officers of the station are coming into close touch with the farmers and securing more widely their confidence and support.

LINES OF WORK.

The principal lines of work conducted by the Kentucky Station during the past year were as follows: Chemistry; soils; analyses of fertilizers, foods, feeding stuffs; field experiments—hemp, tobacco, cereals, legumes, fertilizers; horticulture; plant breeding—wheat, sorghum; breeding of animals; pig feeding; diseases of plants; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation, including balance from previous year	4,683.62
Fees, including balance from previous year	26,393.58
Farm products, including balance from previous year	6,501.02
Miscellaneous, including balance from previous year	331.51
Total	52,909.73

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 93-97, which included reports on variety tests with wheat; commercial fertilizers; the Hessian fly and methods of avoiding its ravages; a general view of the biology of the mosquito, and a study of the species found in Kentucky and methods for their elimination; poisonous and edible mushrooms; analyses of commercial fertilizers; Kentucky forage plants, including the clovers and their allies, a description of them, their adaptability to Kentucky, and their method of assimilating nitrogen from the air; notes on grasses; and analyses of forage plants.

LOUISIANA.

No. 1. Sugar Experiment Station, *Audubon Park, New Orleans.*
No. 2. State Experiment Station, *Baton Rouge.*
No. 3. North Louisiana Experiment Station, *Calhoun.*

Department of Louisiana State University and Agricultural and Mechanical College.

GOVERNING BOARD.

State Board of Agriculture and Immigration: Gov. W. W. Heard, *Baton Rouge;* William Garig (*Vice-President*), *Baton Rouge;* J. G. Lee (*Commissioner*), *Baton Rouge;* Thos. D. Boyd (*President State University*), *Baton Rouge;* Wm. C. Stubbs (*Director State Experiment Station*), *Baton Rouge;* John Dymond, *Belair;* Emile Rost, *St. Rose;* A. V. Eastman, *Lake Charles;* E. T. Sellers, *Walnut Lane;* Charles Schuler, *Keatchie;* H. P. McClendon, *Amite.*

STATION STAFF.

Sugar Experiment Station, *Audubon Park, New Orleans.*

Wm. C. Stubbs, M. A., Ph. D., *Director.*
R. E. Blouin, M. S., *Assistant Director, Chemist.*
P. L. Hutchinson, B. S., *Chemist.*
G. W. Agee, B. S., *Assistant Chemist.*
R. E. Loudon, B. S., *Assistant Chemist.*
Robert Glenk, B. S., *Chemist.*
M. Esnard, B. S., *Assistant Chemist.*
C. A. Browne, jr., Ph. D., *Chemist.*
G. D. Harris, M. S., M. A., *Geologist.*
George Chiquelin, *Sugar Maker.*
R. S. Washington, B. S., *Farm Manager.*
Jas. K. McHugh, *Secretary, Stenographer.*

State Experiment Station, *Baton Rouge.*

Wm. C. Stubbs, M. A., Ph. D., *Director.*
W. R. Dodson, B. A., B. S., *Assistant Director.*
W. H. Dalrymple, M. R. C. V. S., *Veterinarian.*
C. E. Coates, jr., Ph. D., *Chemist.*
H. Skolfield, *Treasurer.*
H. A. Morgan, B. S. A., *Entomologist.*
F. H. Burnette, *Horticulturist.*
B. H. Atkinson, *Farm Manager.*

North Louisiana Experiment Station, *Calhoun.*

Wm. C. Stubbs, M. A., Ph. D., *Director.*
D. N. Barrow, B. S., *Assistant Director.*
Simon Baum, B. S., *Chemist.*
Eugene J. Watson, *Horticulturist.*
A. T. Anders, *Dairyman, Poultryman.*
S. M. Bumpass, *Tobacconist.*

GENERAL OUTLOOK.

The Louisiana stations are giving more attention than ever before to animal production and to the growing and utilizing of fodder for work animals. To this end many varieties of forage plants are being tested at the Sugar Station, where also a number of leguminous crops are being tried as soil renovators. At this place alfalfa, velvet beans, cowpeas, and the red and crimson clovers have been very successful. The work in hybridizing and selecting varieties of cotton has resulted in securing two good varieties which are now being distributed. This station has also originated several superior seedlings of sugar cane which are now being grown by many planters.

At the State Station the principal efforts are now concentrated upon the production of beef cattle. A carload of cattle introduced from Illinois has been immunized to Texas fever and is now being fattened for the Chicago market on home-grown products, such as rice bran, cotton-seed meal, molasses, and roughage. During the year a number of improved Red Polled and Polled Angus cattle have been introduced for breeding purposes. At this station a rotation experiment has been in progress for about twelve years. This rotation consists of corn, oats, and cotton, with two crops of cowpeas introduced between other crops, so as to give five crops in three years. Part of each field has been fertilized and part has remained unfertilized, and the yield of oats and corn on the unfertilized part has nearly trebled. This is an excellent demonstration of what can be done on depleted soils by means of rotation and the use of cowpeas. The agriculturist has taken up an important new line of work, studying the inversion of crude sugars by micro-organisms, which he finds produce marked effects on polarization. The entomologist has discovered that he can easily destroy the cane borer by shallow plowing to cover it. The veterinarian, in cooperation with the entomologist, is studying the nodular disease of the intestines of sheep and is continuing successful work in immunizing cattle to Texas fever. He has devised what is considered a useful press for putting up a complete ration for an animal, including cut hay.

At Calhoun the principal attention is given to experiments with dairy cows, Jerseys and Guernseys, and to dual purpose cows, Devons and Red Polls.

The stations are cooperating with the Bureau of Plant Industry of this Department in growing and studying sweet potatoes. Considerable time of the staff is occupied with farmers' institute work. During the month of June over 40 institutes were held, and later a number were conducted in the sugar district. By recent Congressional action the university with which the State Station is connected has come into full possession of the land, embracing about 150 acres, together with the buildings which it has occupied subject to the needs of the United States for military purposes. From Mr. John Hill, a prominent sugar planter near Baton Rouge, the university has received a bequest of $32,000 for the erection of a fireproof library building, and from the State legislature appropriations of $47,000 for the erection of a dormitory building and a mechanic arts building, and $8,500 for furnishing the library building mentioned above. Increased funds have also been provided by the legislature for the geological survey, which is under the control of the stations and will be conducted in connection with an agricultural survey and soil investigations. The stations also have increased funds from a tax levied by the legislature upon cotton-seed meal. In general, it may be said that the Louisiana stations continue

to be a strong factor for the improvement of agricultural practice in the State. They have strong support in the State, and are called upon more frequently than ever before for advice on all sorts of practical questions. They have come into close contact with the progressive farmers and planters, and are attacking with much vigor the problems which most vitally concern agriculture in the different parts of the State.

LINES OF WORK.

The principal lines of work conducted at the Louisiana stations during the past year were as follows:

Sugar Station.—Chemistry; bacteriology; soils and soil physics; field experiments—tests of fodder plants and varieties of cane; horticulture—tests of home-grown *v.* northern-grown seeds; sugar making; drainage; and irrigation.

State Station.—Chemistry; geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments—forage crops, legumes, rotations, varieties of cotton and sugar cane; horticulture; animal husbandry—breeding and feeding for beef production; diseases of animals—inoculation for Texas fever, study of the nodular disease of the intestines of sheep, anthrax, glanders, etc.; and entomology.

Northern Station.—Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; and dairying.

INCOME.

The income of the stations during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	17,000.00
Fees	8,000.00
Farm products	1,866.05
Miscellaneous, including balance from previous year	8,341.14
Total	50,207.19

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 64 and 65 and the Annual Report for 1901. The report of the veterinarian (Bulletin 64) gives the details of experiments in inoculating cattle for Texas fever, and particulars regarding cases of anthrax, blackleg, glanders, nodular disease of the intestines of sheep, and other diseases that have appeared in the State. Bulletin 65 is a report on the anaylses of commercial fertilizers and Paris green.

MAINE.

Maine Agricultural Experiment Station, *Orono.*

Department of University of Maine.

GOVERNING BOARD.

STATION STAFF.

Charles D. Woods, B. S., *Director.*
J. M. Bartlett, M. S., *Chemist.*
L. H. Merrill, B. S., *Chemist.*
F. L. Russell, B. S., V. S., *Veterinarian.*
W. M. Munson, Ph. D., *Horticulturist.*
G. M. Gowell, M. S., *Stock Breeding, Poultry.*
Gilman A. Drew, B. S., *Zoologist.*
H. W. Britcher, B.C.E., *Assistant Zoologist.*
H. H. Hansen, B. S., *Assistant Chemist.*
E. R. Mansfield, B. S., *Assistant Chemist.*
M. B. Cummins, B. S., *Assistant Horticulturist.*
Annie M. Snow, *Stenographer.*

GENERAL OUTLOOK.

The work of the Maine Station during the past year has been chiefly along lines of food investigations, poultry work, horticulture, and cooperative experiments in growing potatoes. The food investigations have included digestion experiments in cooperation with the Minnesota Station, and dietary studies of lumbermen in cooperation with this Office. The potato experiments are in cooperation with the farmers in Aroostook County, where several fields of potatoes have been secured for culture experiments and tests of fungicides for blight and rot. This year the rot was exceedingly bad on fields which were not sprayed a sufficient number of times, and the year accordingly furnished a good opportunity for the station's demonstrations. Other cooperative enterprises are the studies of the influence of origin of red-clover seed on yield of crop in cooperation with the Bureau of Plant Industry of this Department, and of the available plant food in soils in cooperation with the Bureau of Chemistry. In the poultry investigations the station has succeeded in breeding hens which lay 200 eggs a year, and requests are coming in from foreign countries for breeding stock. The selective breeding has resulted in affecting somewhat the vitality of the hens and the fertility of the eggs. In the work with blueberries efforts have been made to improve the plant by selection and to study root division or grafting as methods of propagation. The efforts of the station along these lines have resulted in such stimulation of the industry that there are now eight blueberry canneries in the

State, from which the output this year was valued at about $100,000. The inspection service performed by the station includes the testing of fertilizers, seeds, feeding stuffs and creamery glassware, and is fully supported by State funds. As heretofore, several members of the station staff assisted at farmers' institutes. The vacancy in the presidency of the university with which the station is connected has been filled by the election of George Emory Fellows, formerly of the University of Chicago.

The work of the Maine Station is showing results of great practical value in the State. The experiments with potatoes have been of very great value to the farmers of Aroostook County and have served also to bring the station into close touch with these farmers, so that its advice is now sought on a great variety of other topics. The work with blueberries, regarding which the station has recently published a bulletin of considerable importance, has been continued for a number of years and has been largely instrumental in developing in the State a large and growing industry. This work and the experiments with poultry are attracting attention outside of the State, as are also the nutrition investigations and other studies requiring long-continued and painstaking research.

LINES OF WORK.

The principal lines of work conducted at the Maine Station during the past year were as follows: Chemistry—study of the manurial value of wood ashes, mucks, seaweeds, and bone, and of seaweed as a cattle feed, miscellaneous analytical work; botany; inspection of fertilizers, concentrated commercial feeding stuffs, seeds, and creamery glassware; horticulture—experiments in the selection, propagation, and improvement of blueberries, study of hardy fruits and vegetables; diseases of plants—fungus diseases of potatoes and other plants; food and nutrition of man and animals; poultry raising—breeding and feeding experiments; marine invertebrates; diseases of animals; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	4,213.25
Farm products	3,078.66
Balance from previous year	73.89
Total	22,365.80

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 73–82, and the Annual Reports for 1900 and 1901. The bulletins were on the following subjects: Experiments with fungicides upon potatoes in 1900; how to fight potato enemies; the manurial value of ashes, mucks, seaweeds, and bone; analyses of miscellaneous food materials; the horticultural status of the genus Vaccinium; fertilizer inspection; finances, meteorology, index; poultry experiments in 1900 and 1901; feeding stuff inspection; fertilizer inspection; orchard notes. The Annual Report for 1900 contains reprints of Bulletins 59–69, and the Annual Report for 1901 reprints of Bulletins 70–78. A number of press bulletins have also been issued.

MARYLAND.

Maryland Agricultural Experiment Station, *College Park.*

Department of Maryland Agricultural College.

GOVERNING BOARD.

Board of Trustees—Agricultural Committee: Gov. John W. Smith, *Annapolis;* Chas. H. Stanley, *Laurel;* Chas. W. Slagle, *Baltimore;* David Seibert, *Clearspring;* Murray Vandiver, *Havre de Grace;* Chas. A. Councilman, *Glyndon;* Allen Dodge, *Washington, D. C.;* Noble L. Mitchell, *Bel Air.*

STATION STAFF.

Harry J. Patterson, B. S., *Director; Chemist.*
James S. Robinson, *Horticulturist.*
A. L. Quaintance, M. S., *Entomologist.*
Samuel S. Buckley, D. V. S., *Veterinarian.*
W. T. L. Taliaferro, M. A., *Agriculturist.*
J. B. S. Norton, M. S., *Botanist, Vegetable Pathologist.*
E. O. Garner, *Superintendent Farm, Recorder of Experiments.*
Ralph I. Smith, B. S., *Assistant Entomologist.*
C. F. Austin, B. S., *Associate Horticulturist.*
C. F. Doane, M. S. Agr., *Dairy Husbandman and Bacteriologist.*
F. H. Blodgett, B. S., *Assistant Plant Pathologist, Botanist.*
Jos. R. Owens, M. D., *Treasurer.*
B. H. Gibbs, *Clerk.*
Thos. H. White, *Gardener.*

GENERAL OUTLOOK.

The work of the Maryland Station during the past year has followed, in the main, lines of work previously inaugurated in agronomy, horticulture, animal production, dairying, veterinary science, and studies of insect pests and plant diseases incidental to the enforcement of the State horticultural law, which is intrusted to station officers. Studies of the comparative digestibility of raw, pasteurized, and cooked milk and on the disinfectant properties of washing powders have been brought to a close and the results published. Among the investigations more recently undertaken are a study upon the effects of different

kinds of baking powders upon the digestibility of breads, methods for removing garlic odors from milk and butter, causes which produce pithiness in celery, rotation of vegetables for forcing in greenhouses, and bovine tuberculosis with a herd of condemned cows. The station is cooperating with numerous farmers in different parts of the State in testing varieties, methods of culture, and use of spraying materials, and with the bureaus of this Department, as follows: Bureau of Plant Industry in cereal investigations, influence of origin of red clover seed on yield of crop, best crops for use in securing a continuous soiling series for dairy and farm stock; Bureau of Chemistry in investigations of the gluten content of wheat and the influence of environment on the sugar content of muskmelons; Bureau of Soils in a soil survey. Members of the staff have assisted at farmers' institutes as heretofore.

The last legislature of the State voted the station an annual appropriation of $5,000 to be used for repairs, insurance, printing, making exhibits of results of station work, and conducting experiments in meat production, tobacco growing, and irrigation. Under the terms of this law the station proposes to extend its efforts to carry the results of the station work to the farmers of the State by preparing educational exhibits based mainly on station work for use at agricultural fairs, the exhibits ultimately to form a part of an agricultural museum.

The Maryland Station is developing its work along a few safe and important lines, and is winning the confidence and esteem of the farmers of the State, in this way doing much to improve agricultural methods. Much of this work has been in progress for a number of years, and valuable results are becoming apparent. There seems to be a good opportunity to undertake irrigation work for the purpose of showing the profit in irrigating market garden crops in the vicinity of large cities, and the best practical means of securing and using irrigating water. The State appropriation for the station is a substantial recognition of the value of the station to the farming interests of the State and is very encouraging.

LINES OF WORK.

The principal lines of work conducted at the Maryland Station during the past year were as follows: Chemistry—analytical work, study of milk preservatives, baking powders, etc.; soils; field experiments—tests of varieties of forage crops, soil renovators, corn, potatoes, and wheat, cultural and fertilizer experiments; horticulture—orchard management, variety tests, cover crops, cultural methods, breeding and selection of strawberries and carnations, rotation of vegetables in the forcing house, systematic study of fruit areas in Maryland; diseases of plants; feeding experiments; diseases of animals; entomology—inspection of orchards, study of life history of injurious insects.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	4,808.89
Balance from previous year	723.34
Total	20,532.23

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 75–81 and the Annual Report for 1901. Investigations upon which results have been published include the effect of hydrocyanic acid gas upon grains and other seeds; parturient paresis—milk fever, calving fever; the comparative digestibility of raw, pasteurized, and cooked milk; the dehorning of stock; the disinfectant properties of washing powders, acute epizootic (leucoencephalitis) in horses; soils and fertilizers for greenhouse crops. In the study on the comparative digestibility of raw, pasteurized, and cooked milk it was found that the digestibility of the milk fed would average about 93 per cent with the protein and a little higher with the fat. The percentage of digestibility might possibly have been increased somewhat by reducing the ration, "but where sufficient milk is fed to insure substantial growth, nearly one-tenth of the dry substance is undigested. Raw milk is more easily digested when fed to calves than either pasteurized or cooked milk. Contrary to theory, cooked milk when fed to the calves used in these experiments caused violent scouring in the majority of trials. The majority of physicians in charge of children's hospitals corresponded with favored the use of raw milk for infants when the milk is known to be in perfect condition, but favored pasteurized milk under ordinary conditions. With one exception all the physicians corresponded with discouraged the use of cooked or sterilized milk for infant feeding."

MASSACHUSETTS.

Hatch Experiment Station of the Massachusetts Agricultural College, *Amherst.*

Department of the Massachusetts Agricultural College.

GOVERNING BOARD.

James Draper (*Chairman*), *Worcester;* James W. Stockwell, *Boston;* William Wheeler, *Concord;* Elijah W. Wood, *West Newton;* William H. Bowker, *Boston;* Henry H. Goodell, *Amherst.*

STATION STAFF.

H. H. Goodell LL. D., *Director.*
William P. Brooks, Ph. D., *Agriculturist.*
George E. Stone, Ph. D., *Botanist, Mycologist.*
Chas. A. Goessmann, Ph. D., LL. D., *Honorary Director, Chemist* (Fertilizers).
Joseph B. Lindsey, Ph. D., *Chemist* (Foods and Feeding).
Chas. H. Fernald, Ph. D., *Entomologist.*
F. A. Waugh, M. S., *Horticulturist.*
J. E. Ostrander, C. E., *Meteorologist.*
Henry M. Thomson, B. S., *Assistant Agriculturist.*
Ralph E. Smith, B. S., *Assistant Botanist and Mycologist.*
Henri D. Haskins, B. S., *Assistant Chemist* (Fertilizers).
James E. Halligan, B. S., *Assistant Chemist* (Fertilizers).
Daniel Lunt Cleaves, B. S., *Assistant Chemist* (Fertilizers).
Edward B. Holland, M. S., *First Chemist* (Foods and Feeding).
Philip H. Smith, B. S., *Assistant Chemist* (Foods and Feeding).
Henry T. Fernald, Ph. D., *Associate Entomologist.*
George A. Drew, B. S., *Assistant Horticulturist.*
S. C. Bacon, *Observer.*
George F. Mills, *Treasurer.*

GENERAL OUTLOOK.

The Massachusetts Station during the past year has handled a large amount of work, both investigative and inspectional. The latter work has been increased during the year by the enactment of a State nursery inspection law, carrying an appropriation for expenses and per diem. The brown-tail moth, San José scale, and gypsy moth are looked for in this inspection, which is in the hands of the entomologist. He has also considerable work in progress on economic insects, the use of insecticides, etc., and is employing special and postgraduate students in his work, thus adding materially to the resources of the department. The botanist has been studying a number of plant diseases, especially those affecting melons, cucumbers, lettuce, and tomatoes. The work of the station in sterilizing soils for greenhouse work is bearing much fruit. The greenhouse men are sterilizing their soil very extensively with good results in promoting seed germination and plant growth, as well as freedom from diseases and nematodes. The horticultural work will be continued along old lines and problems in pruning and propagating plums will be undertaken. The department of foods and feeding has continued investigations on the digestibility of legumes at different stages of growth and on the effect of feeds on the quality of butter. The agricultural department has continued a large amount of interesting and valuable plat and pot work with grasses, legumes, and fertilizers, from which some important results have been obtained. Tests of different forms of potash on clover have shown the sulphate to give much better results than the muriate or kainit. During the year the horticulturist resigned and was succeeded by F. A. Waugh, of the Vermont College and Station. A number of changes have occurred also among the assistants on the staff.

The different departments of the Massachusetts Station are in very close touch with agricultural practices and are called upon for a good deal of advice. It is believed that a larger amount of cooperation between different departments is desirable, and would enable the station to get a still greater return from its funds and equipment. This station is already doing a large amount of useful work, much of which is of scientific value and wide practical application.

LINES OF WORK.

The principal lines of work conducted at the Massachusetts Hatch Station during the past year were as follows: Chemistry—miscellaneous analytical work, studies of legumes and plants affecting the quality of butter; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments—plat experiments with fertilizers, grasses, and various farm crops, supplemented by similar pot experiments; horticulture—varieties of peaches, grapes, and other fruits, raspberry hybrids, investigations with plums, study of the effect of electricity and illuminating gas on plants and trees; diseases of plants, especially those of melons, cucumbers, and lettuce; digestion and feeding experiments; diseases of animals; entomology—study of the life history of economic insects and the use of insecticides; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	11,200.00
Fees	3,405.00
Farm products	2,274.66
Miscellaneous	2,319.66
Total	34,199.32

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 75–82, Meteorological Bulletins 149–161, and the Annual Report for 1901. Bulletins 75, 77, 78, and 81 contain reports of analytical work with fertilizers, manures, and concentrated feeding stuffs. The other subjects upon which reports have been published are the imported elm-leaf beetle, growing china asters, fungicides and insecticides, orchard management, cover crops in orchards, and pruning of orchards.

MICHIGAN.

Experiment Station of Michigan State Agricultural College, *Agricultural College.*[a]

Department of Michigan State Agricultural College.

GOVERNING BOARD.

State Board of Agriculture: T. F. Marston (*President*), *Bay City;* Franklin Wells, *Constantine;* Chas. J. Monroe, *South Haven;* Gov. A. T. Bliss, *Lansing;* Jonathan L. Snyder (*President College*), *Agricultural College;* E. P. Allen, *Ypsilanti;* R. D. Graham, *Grand Rapids;* L. W. Watkins, *Manchester.*

STATION STAFF.

Clinton D. Smith, M. S., *Director; Agriculturist.*
L. R. Taft, M. S., *Horticulturist.*
Robert S. Shaw, B. S. A., *Live Stock.*
R. H. Petitt, B. S. A., *Entomologist.*
C. E. Marshall, Ph. D., *Bacteriologist.*
F. W. Robison, B. S., *Chemist.*
F. S. Kedzie, M. S., *Associate Chemist.*
M. L. Dean, *Assistant Horticulturist.*
George A. Waterman, D. M. V., *Consulting Veterinarian.*
B. O. Longyear, *Consulting Botanist.*
Mrs. L. E. Landon, *Librarian.*
T. A. Farrand, *in Charge of Substation* (*South Haven*).
Leo M. Geismar, *in Charge of Substation* (*Chatham*).
Cassius Parsons, *Clerk, Stenographer.*

GENERAL OUTLOOK.

The chief features of the work of the Michigan Station during the past year have been the investigation of various problems concerned in the production of sugar beets and the utilization of their by-products; study of methods of handling muck soils; study of the effect of aeration of milk and the interchange of gases between air and milk on the oxidation, absorption, and elimination of odors and taints, on the number of bacteria, and on fermentation. This study of problems in the aeration of milk by the bacteriologist of the station is the most exhaustive that has ever been made, and is a valuable contribution to science. A detailed account of the study has recently been published as Special Bulletin 16 of the Michigan Station, and a popular treatise on the subject appears in Bulletin 201 of the regular series. The work with sugar beets has included not only methods of production, but also methods of utilizing their by-products by feeding to cattle and sheep; production of beet seed in Michigan, and the repression of fungus diseases and insect pests. Much of this work is done in cooperation with farmers, with whom the station has been able to arrange experiments on favorable terms. The study of muck soils has led to the conclusion that an application of horse manure and potash, with heavy rolling (not plowing), is the best method of handling them. This discovery has been of much value to the owners of muck lands

[a] Freight and express address, *Lansing.*

in the State. The station is cooperating with the Bureau of Plant Industry of this Department in experiments with sand-binding grasses along the lake shores, in studying the influence of the origin of red-clover seed on the yield of crop, and in growing sugar-beet seed; with the Bureau of Chemistry in the investigation of sugar-beet problems, the gluten content of wheat, and the available plant food in soils; and with the Bureau of Soils in a soil survey.

Work with fruits at the South Haven Substation has been continued as heretofore with a State appropriation of $2,000, as have also the experiments with field crops, vegetables, and fruits at the Chatham Substation in the Northern Peninsula with a State appropriation of $3,000.

A new bacteriological building with adjacent hospital and crematory has been completed at a cost of about $23,500. This building will furnish laboratory facilities for the bacteriologist of the station. During the year the agriculturist resigned to accept the position of government professor of agriculture in South Australia, and subsequently the director was put in charge of this work and relieved of the superintendency of farmers' institutes. At the same time the horticulturist was relieved of college duties and put in charge of farmers' institutes and orchard and nursery inspection. The consulting botanist resigned to accept a position in the Bureau of Plant Industry of this Department, and was succeeded by B. O. Longyear, instructor in botany in the college. E. E. Bogue was elected professor of forestry in the college, and R. S. Shaw, formerly of Montana, professor of agriculture, the latter also to have charge of live-stock experiments at the station. On November 7, 1902, occurred the death of Dr. Robert C. Kedzie, who had been at the head of the chemical department of the college since 1863 and chemist of the station since its organization. He was a pioneer in agricultural education and research in this country, a powerful champion of the college in its early struggles for existence, a student and investigator of agricultural problems before experiment stations were organized in any of the States, a zealous and unflinching antagonist of the frauds perpetrated upon farmers in his State, and the originator of the farmers' institute in Michigan as an agency for carrying information to the farmers. In his death the Michigan College and Station lost one of its wisest counselors and agricultural science an honored investigator.

The college with which the station is connected has been given a largely increased annual income by the State, and it is hoped that in the future the station may have its funds for research extended. By a somewhat more compact organization and the concentration of the time and energy of station officers more fully on research work it is believed that the good work already being done by this station might be materially increased to the great benefit of the agriculture of the State.

LINES OF WORK.

The principal lines of work conducted at the Michigan Station during the past year were as follows: Chemistry—analysis and control of fertilizers and feeding stuffs, analysis of breakfast foods and condiments; bacteriology—aeration of milk, its effect on gases, souring, etc., study of milk supply and the bacteria of the dairy; soils; field experiments—fertilizer, cultural, and variety tests with sugar beets and many other field crops, production of sugar-beet seed, rotations, experiments with cowpeas, soy beans, and other legumes, breeding and selection of wheat; horticulture—variety tests and orchard management; diseases of plants—fungus diseases of the sugar beet, clover, and fruits; feeding experiments—utilization of cowpeas, soy beans, and other legumes, comparison of corn silage with dried corn fodder and with beet pulp, fattening lambs with beet pulp; diseases of animals; entomology; and stable hygiene.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	5,000.00
Fees	1,860.00
Farm products	2,736.08
Miscellaneous, including balance from previous year	1,976.14
Total	26,572.22

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 189–198, Special Bulletin 14, and the Annual Report for 1901. The Annual Report contains brief reports by the director and the heads of the different departments and reprints of Bulletins 186, 192, and Special Bulletin 14. The subject of the latter bulletin is foul brood, and those of the regular bulletins received are notes on strawberries, vegetable tests for 1900, shrinkage of farm products, fertilizer analyses, some experiments with beet pulp as a stock food, report of South Haven Substation for 1901, strawberry notes for 1901, notes on vegetables, sugar-beet experiments in 1901, and sand lucern.

MINNESOTA.

Agricultural Experiment Station of the University of Minnesota, *St. Anthony Park, St. Paul.*

Department of the University of Minnesota.

GOVERNING BOARD.

Board of Regents: Greenleaf Clark (*President*), *St. Paul;* William M. Liggett, *St. Anthony Park;* Stephen Mahoney, *Minneapolis;* Elmer E. Adams, *Fergus Falls;* Thomas Wilson, *St. Paul;* A. E. Rice, *Willmar;* O. C. Strickler, *New Ulm;* James T. Wyman, *Minneapolis;* T. L. Schurmeier, *St. Paul;* Gov. Samuel R. Van Sant, *Winona;* Cyrus Northrop, *Minneapolis;* John W. Olson, *Albert Lea;* J. E. Ware (*Treasurer*), *Minneapolis.*

STATION STAFF.

William M. Liggett, *Director.*
Willet M. Hays, M. Agr., *Agriculturist.*
Samuel B. Green, B. S., *Horticulturist.*
Harry Snyder, B. S., *Chemist.*
T. L. Haecker, *Dairy Husbandman.*
M. H. Reynolds, M. D., V. M., *Veterinarian.*
F. L. Washburn, M. A., *Entomologist.*
Andrew Boss, *Animal Husbandman.*
T. A. Hoverstad, B. Agr., *Superintendent* (*Crookston*).
H. H. Chapman, B. S., B. Agr., *Superintendent* (*Grand Rapids*).
J. A. Hummel, B. Agr., *Assistant Chemist.*
C. P. Bull, B. Agr., *Assistant in Agriculture.*
John Thompson, B. Agr., *Assistant in Agriculture.*
Beyer Aune, *Farm Foreman.*

GENERAL OUTLOOK.

At the Minnesota Station no change in policy and but few in general lines of work have been made during the past year. Plant breeding for the improvement of cereals, grasses, and legumes continues to be the most prominent feature of the work. By means of specially devised apparatus for grading, planting, and thrashing, supplemented by carefully kept records and judicious methods of distributing improved varieties through the agency of substations and reputable farmers, the work in plant breeding is now reduced to a very thorough system. This work is conducted in cooperation with other Northwestern stations and with the Bureau of Plant Industry of this Department. A recent publication of the station (Bulletin 72) gives results of experiments in forestry and horticulture at Coteau Farm which indicate that for the successful production of fruit in that locality the protection of forest trees is necessary. In connection with the work of the station chemist on the food and nutrition of man, conducted in cooperation with this Office, his investigations regarding the nutritive value of different kinds of flour will be greatly facilitated by the addition to his equipment of a small flour mill which will enable him to control absolutely the milling of the grain and the separation of the various mill products desired for the investigations. The station is also cooperating with the Bureau of Chemistry in studying the avail-

FIG. 1.—MINNESOTA COLLEGE AND STATION—VETERINARY BUILDING.

FIG. 2.—MINNESOTA COLLEGE AND STATION—AGRICULTURAL CHEMISTRY BUILDING.

able plant food in soils, with the Bureau of Soils in a soil survey, and with the Division of Statistics in collecting farm statistics.

This last enterprise is a new and rather unique inquiry into the cost of producing field crops and live-stock products. At Northfield in southeastern Minnesota, at Halstad in the Red River Valley, and at Marshall in southwestern Minnesota statisticians have been employed for the entire twelve months of 1902. Each of these statisticians has a route something like the route of a rural mail carrier. He travels 15 or more miles and visits from fifteen to twenty farms on his route each day. He carries with him a map of each farm and interviews the farmer regarding the labor applied to each field, to each bunch of live stock, and to each other definite enterprise on the farm. At the end of the season the fields will be measured, and the tabulated results should show the number of hours of man labor and of horse labor applied to grow each acre of each kind of crop. The facts thus secured will enable the experiment station to make practical application of the results in its rotation and other field experiments and will be of value also in teaching farm management in the school and college of agriculture.

The veterinary building (Pl. II, fig. 1), recently completed at a cost of $25,000, is a commodious two-story brick structure containing on the first floor a laboratory, physiology class room, veterinary lecture and operating room, contagious-disease ward, box-stall ward, single-stall ward, and a combined drug and instrument room, and on the second floor a large museum and class laboratory room, office, dark room, and haymows. A new agricultural chemistry building (Pl. II, fig. 2) to cost $25,000 is nearing completion. A vacancy caused by the death of the entomologist was filled by the appointment of F. L. Washburn, formerly of the Oregon College and Station. During the year the animal husbandman retired from station and college work to engage in agricultural journalism and was succeeded by A. Boss, who was promoted from the position of assistant in agriculture. Assistants in agriculture have been appointed to undertake work in rural engineering, field crops and farm management, and rural school agriculture. A new movement for the introduction of agriculture into rural schools has been placed under W. M. Hays, who has prepared and distributed among the rural schools a bulletin containing about two hundred exercises for use in this work.

The Minnesota Station is obtaining results of great practical importance to the agriculture of the State. It is estimated that the development and introduction of improved varieties of cereals has added hundreds of thousands of bushels to the grain product of the State. Similarly, in dairying, horticulture, forestry, chemistry, entomology, and other lines, results of pecuniary value are being reached. This meets with hearty approval from the people of the State, who in turn provide liberally for the support of the college and station.

LINES OF WORK.

The principal lines of work conducted at the Minnesota Station during the past year were as follows: Chemistry of soils and farm crops; field experiments—rotations, tests of varieties of cereals and forage crops, proportion of flax and wheat to use when sown together, time and depth of seeding grains and amount of seed, methods of seeding grasses; horticulture—tests of varieties of fruits and vegetables, use of wind-breaks, testing hardy stocks for apple trees, improvement of native fruits; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	[a]42,130.01
Farm products	[a]13,579.11
Total	70,709.12

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 70–72. These bulletins record the investigations in prairie forestry and horticulture at Coteau Farm, in milk production, and on the influence of wheat farming upon soil fertility. An important deduction has been drawn from the investigations in milk production, viz, that dairy cows may be successfully maintained with high productive capacity on a ration containing much less protein than that given in generally accepted feeding standards.

MISSISSIPPI.

Mississippi Agricultural Experiment Station, *Agricultural College.*[b]

Department of Mississsippi Agricultural and Mechanical College.

GOVERNING BOARD.

[a] Including substations.

[b] Telegraph address, *Starkville*; express, post-office, and freight address, *Agricultural College.*

STATION STAFF.

W. L. Hutchinson, M. S., *Director; Chemist.*
E. B. Ferris, M. S., *Assistant Director, in charge McNeill Substation.*
E. R. Lloyd, M. S., *Assistant Director, Agriculturist.*
G. W. Herrick, B. S., *Botanist, Entomologist.*
A. B. McKay, B. S., *Horticulturist.*
J. C. Robert, V. M. D., *Veterinarian.*
W. R. Perkins, M. S., (*Associate*) *Chemist.*
J. S. Moore, M. S., *Dairy Husbandman.*
R. C. King, B. S., *Treasurer.*
Maude Butler, *Stenographer.*

GENERAL OUTLOOK.

The work of the Mississippi Station during the past year has been devoted largely to subjects concerning the restoration and maintenance of soil fertility and the introduction of animal production as a means of accomplishing this object. The station has about 60 head of beef cattle and is studying the cost of beef production, the best crops to grow for making beef, and the practicability of the process. This is a very important line of work, and the station is making a thorough study of the whole question, including the production of pasturage and the cheapest crops to tide over the feeding season, for the purpose of determining definitely whether beef production can be incorporated into the farming system of the South, and whether it can safely be recommended to farmers under present conditions. Some attention is being given also to the maintenance of a dairy herd, the handling and manufacture of dairy products in a warm climate, and the diseases affecting live stock, especially Texas fever. Studies of artesian waters and soil investigations have been continued, the latter in cooperation with the Bureau of Soils of this Department. The entomologist is devoting his attention principally to insects attacking pecans and to the chicken mite and the peach-tree borer.

The Mississippi College, with which the station is connected, received last year very liberal appropriations from the legislature of the State. Besides making provision for chairs of geology and mining and of civil and rural engineering, both of which are new, the appropriations carried the following provisions for improvements and work: A new building for agriculture and horticulture, scientific departments, library, and museum, $40,000; infirmary building, $10,000; additional equipment for textile school, $13,030; additional equipment for mechanic arts department, $8,300; enlarging capacity of mechanic arts building, $5,000; residence of director of textile school, $1,500; equipment for English, veterinary, preparatory, agricultural, horticultural, and biological departments, $1,900; farmers' institutes for 1902–3, $6,000.

For a branch experiment station at McNeill $13,000 for the biennial period of 1902–3 was also appropriated. For this substation about 2,000 acres, mostly timber land, has been donated. This is in the pine woods section of the State, where the use of fertilizers is considered necessary. E. B. Ferris has been made assistant director in charge of investigations at this place. Forty acres of the land have been cleared

and a number of buildings erected, including a two-story residence, containing eight rooms, for the director; a cottage for the foreman; four double cabins for laborers, and a barn. The clearing was accomplished in time for the planting of corn, cotton, cowpeas, sorghum, peanuts, sugar cane, strawberries, tomatoes, asparagus, and chufas. The growing of fruit will be undertaken later. The action of the legislature in appropriating for this branch station is the first substantial recognition on the part of the State of the importance of the work of the experiment station and the value of investigations as a basis for improving agricultural practice.

With the increase of the financial resources of the college, the station should be relieved of the burden of certain general expenses of the institution which it has hitherto borne, and the station officers should be freed from teaching and general business which interferes with the vigorous and continuous prosecution of investigations. The station is dealing with problems of vital importance to the great agricultural interests of the State, and should be encouraged to put forth the most strenuous efforts to solve these problems.

LINES OF WORK.

The principal lines of work conducted by the Mississippi Station during the past year were as follows: Soils—restoring and maintaining fertility, study of artesian waters; fertilizers; field experiments—growing pasturage and forage crops, testing varieties of wheat, oats, and cotton; horticulture; animal husbandry—beef production; dairying; diseases of animals—Texas fever; entomology—chicken mite and insects on pecans and peach trees.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,112.32
Miscellaneous, including balance from previous year	277.37
Total	16,389.69

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 68–75 and the Annual Report for 1901. These bulletins included studies on Texas fever, milk fever, and anthrax; reports on the analysis of commercial fertilizers; records of station cows;

feeding dairy cows; strawberry culture in Mississippi, and a study of mosquitoes in Mississippi and how to deal with them. These subjects were also treated briefly in the Annual Report, which included in addition chapters on forage crops, feeding experiments, insects affecting pecans, and the horn fly. It has been found that the horn fly can be destroyed by spraying cattle with a 20 or 25 per cent mixture of kerosene and water, or better by spraying with crude petroleum, either undiluted or a 50 per cent solution.

MISSOURI.

Missouri Agricultural College Experiment Station, *Columbia.*

Department of the College of Agriculture and Mechanic Arts of the University of Missouri.

GOVERNING BOARD.

Board of Curators—Executive Committee: Campbell Wells (*President*), *Platte City;* R. B. Oliver, *Cape Girardeau;* G. F. Gmelich, *Boonville.*

Advisory Council: The Missouri State Board of Agriculture.

STATION STAFF.

Henry J. Waters, B. S. A., *Director.*
Paul Schweitzer,[a] Ph. D., *Chemist.*
J. C. Whitten, M. S., Ph. D., *Horticulturist.*
J. M. Stedman, B. S., *Entomologist.*
J. W. Connaway, M. D. C., M. D., *Veterinarian.*
F. B. Mumford, M. S., *Animal Breeding.*
C. H. Eckles, B. Agr., M. S., *Dairying.*
George M. Tucker, B. S., Ph. D., *Agronomist.*
E. L. Shaw, B. S., *Assistant in Agriculture.*
W. L. Howard, B. S., *Assistant in Horticulture.*
B. M. Duggar, Ph. D., *Botanist.*
R. M. Bird, Ph. D., *Acting Chemist.*
John Schnabel, *Gardener.*
J. G. Babb, M. A., *Secretary.*
R. B. Price, *Treasurer.*
Estelle Hickok, *Clerk, Stenographer.*

GENERAL OUTLOOK.

The Missouri Station has continued its important work in relation to the fruit industry of the State and has made considerable progress in specializing its agricultural work. The director is making a specialty of feeding problems with reference to the influence of age, condition, and size of steers upon the economy of beef production; F. B. Mumford is giving attention to breeding problems, especially in the factors influencing the weight of animals at birth, and G. M. Tucker, who has been put in charge of the recently established department of agronomy, is giving particular attention to extending the growth of alfalfa in the State. The dairyman is studying feeding problems and trying to arouse interest in dairying throughout the State and is planning to demonstrate on a commercial scale the feasibility of curing cheese at

[a] On leave.

low temperatures. The fertilizer inspection work is becoming more important, and consequently more productive of funds for the station. The investigations in cooperation with this Department now include studies of the influence of origin of red clover seed on yield of crop and of the formation and management of meadows with the Bureau of Plant Industry, investigations of the gluten content of wheat and of the available plant food in soils with the Bureau of Chemistry, a soil survey with the Bureau of Soils, and irrigation investigations with this Office.

The funds provided by the last legislature for printing station publications have enabled the station to issue several bulletins recently. With the appropriations for building, made at the same time, a dairy building (Pl. III, fig. 1) and a live stock building have been completed and a horticultural building is nearing completion. The latter will include facilities for the departments of horticulture, botany, and entomology, and will have connected with it two glass houses. The officers of the station and of the college with which it is connected are actively engaged in promoting agricultural education in the State normal schools, the rural schools, and through farmers' institutes, and have recently inaugurated, in cooperation with one of the railroads of the State, a series of institutes with exhibition cars. The work of both college and station is in a flourishing condition and is being prosecuted with great energy and with much success.

LINES OF WORK.

The principal lines of work conducted at the Missouri Station during the past year were as follows: Chemistry—inspection of fertilizers, study of food adulterants, digestion studies; field experiments—cereal and forage crops, fertilizers, rotations, renovating worn-out soils; horticulture—experiments with apples, plums, grapes, peaches, pears, small fruits, and nuts, breeding experiments with fruits, diseases of apples; feeding experiments with beef cattle, sheep, and swine; diseases of animals, especially those of swine; entomology—study of ticks on cattle, parasites of sheep, and insects affecting fruits; dairying; and drainage and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	3,460.85
Fees	2,087.69
Balance from previous year	3,770.44
Miscellaneous	72.45
Total	24,391.43

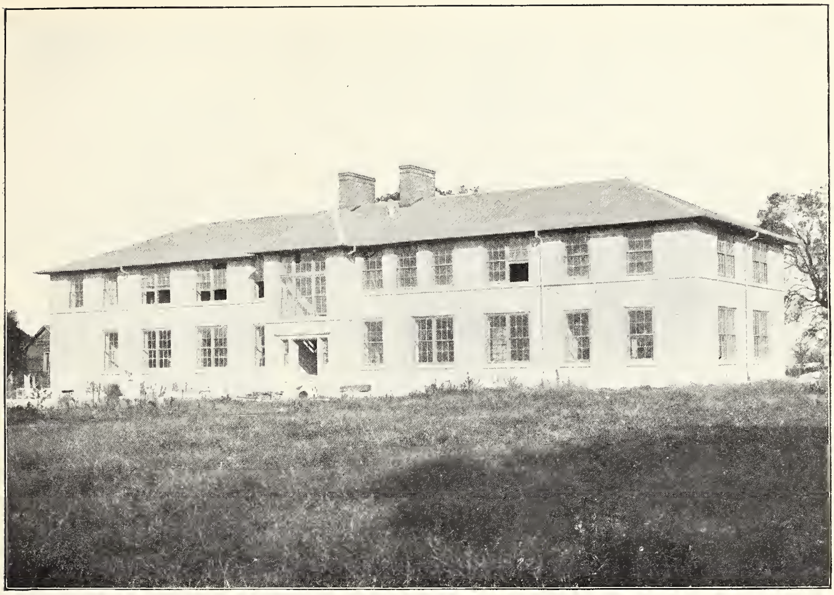

FIG. 1.—MISSOURI COLLEGE AND STATION—DAIRY BUILDING.

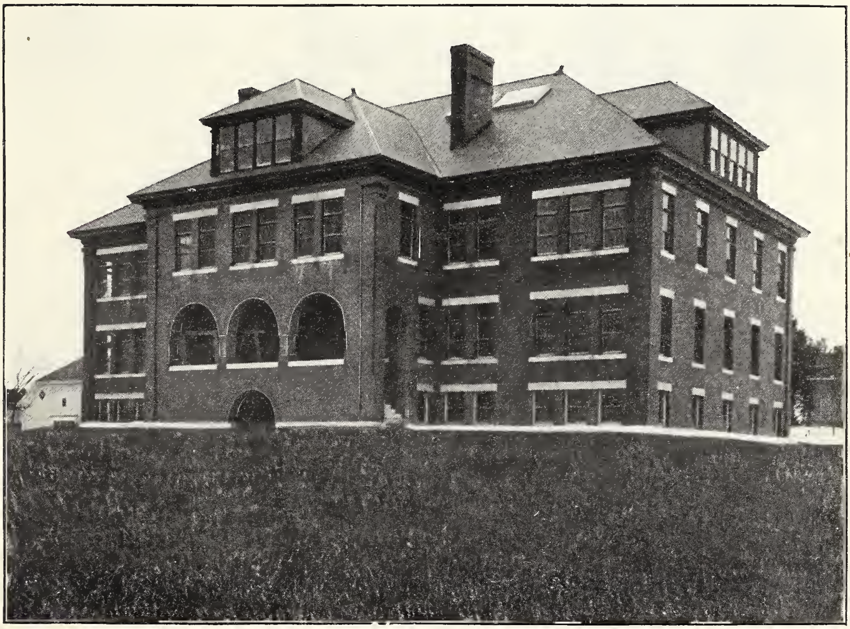

FIG. 2.—NEW HAMPSHIRE COLLEGE AND STATION—AGRICULTURAL BUILDING.

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

No publications have been received from this station during the past year.

Missouri State Fruit Experiment Station, *Mountain Grove.*

GOVERNING BOARD.

STATION STAFF.

J. T. Stinson, B. S., *Director.*
Frank Horsfall, B. S., *Assistant Horticulturist.*
F. W. Faurot, B. S., *Assistant in Investigation of Plant Diseases.*
A. M. Swartwout, *Field Assistant.*

GENERAL OUTLOOK.

The Missouri State Fruit Experiment Station has made considerable progress during the past year in the inauguration of several lines of work related to the fruit interests of the State. These include investigations with orchard and small fruits, experiments in cooperation with fruit growers in testing fertilizers and cover crops for orchards, investigations of diseases and insects affecting orchard trees and fruits, and a survey of all orchards in the vicinity of Mountain Grove containing 10 acres or over. Experiments are also under way to test the advisability of planting orchards on new land. Much attention is given to the cross fertilization of apples and strawberries. During the present season the station put out over 900 new varieties of strawberries originated in this way, and the next spring a 2-acre planting of apple seedlings originated in the same way will be put out.

During the winter and spring the station carried on a unique educational propaganda throughout the Ozark region. Two trips through the region were made with a railroad car fitted up as an exhibit car. It was furnished free and hauled from place to place by one of the railroad companies. It contained an exhibit of all the best makes of spray pumps and spray nozzles, a collection of injurious insects and specimens of fungus diseases and a microscope with which to examine them, and materials for making the different spraying mixtures. The trips were extensively advertised in advance, and at each place where the car stopped a large crowd of fruit growers assembled. A day was spent at each place. The apparatus was examined, demonstrations were made, and in the afternoons and even-

ings institutes for fruit growers were conducted by station men. The plan proved to be eminently satisfactory, and was a valuable means of instruction for the fruit growers.

LINES OF WORK.

The principal lines of work conducted at the Missouri State Fruit Experiment Station during the past year were as follows: Horticulture—experiments with fertilizers and cover crops for orchards; breeding experiments with apples and strawberries; orchard survey; tests of new land for orchard purposes; study of crown gall, bitter rot, root rot, and other diseases affecting fruits; experiments and studies of injurious insects; experiments with insecticides and fungicides; and inspection of orchards and nurseries.

INCOME.

The station is supported entirely by State appropriation, the amount for the years 1901 and 1902 being $26,525.

MONTANA.

Montana Agricultural Experiment Station, *Bozeman.*

Department of the Montana College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Executive Board: Walter S. Hartman (*President*), *Bozeman;* Peter Koch (*Secretary and Treasurer*), *Bozeman;* John M. Robinson, *Bozeman;* Joseph Kountz *Bozeman;* E. B. Lamme, *Bozeman.*

STATION STAFF.

S. Fortier, M. E., *Director; Irrigation Engineer.*
F. W. Traphagen, Ph. D., *Chemist.*
F. B. Linfield, B. S. A., *Agriculturist, Animal Husbandman.*
Henry C. Gardner, *Poultry Department.*
R. W. Fisher, *Assistant Horticulturist.*
Edmund Burk, *Assistant Chemist.*
J. W. Blankinship, Ph. D., *Botanist.*
Robert A. Cooley, B. S., *Zoologist.*
M. A. Lamme, *Stenographer and Clerk.*

GENERAL OUTLOOK.

The Montana Station was free from notable changes of any kind during the past year, and was thus enabled to develop much valuable work along a few well chosen lines of practical usefulness to the farmers of the State. Irrigation investigations are of paramount importance in Montana, a fact which was recognized by the last legislature in making a $2,000 appropriation to aid this work. Many different problems in irrigation are receiving attention, and it is worthy of note that

the duty of water experiments conducted by the station extended over an area of over 42,000 acres. The station is cooperating to a limited extent with the United States Geological Survey in irrigation investigations and more extensively with this Office. The director has undertaken the publication of a series of popular irrigation bulletins adapted to Montana conditions, the first of which, Farmers' Weirs, has been issued as Bulletin 34. Press bulletins and popular articles are also used with success in disseminating information regarding the work of the station. There has been well directed work also in agronomy, animal husbandry, chemistry, entomology, and other lines. The work in the improvement of cereals has resulted in the development of a number of valuable varieties which are being generally distributed. This is especially true of two varieties of oats found peculiarly suited to Montana conditions. Cooperative tests of these improved grains and of sugar beets are in progress with a large number of farmers. The distribution of improved fruits and breeds of live stock and tests of grasses and forage plants adapted to dry ranges and irrigated lands are prominent features of the station work. The animal husbandry problems attacked are usually the simpler ones confronting the practical ranchman, such as the relative profits from good, medium, and poor animals, and the most profitable combination of the available feeding stuffs. The chemist finds several sections of the State well adapted to the production of sugar beets. The entomologist is making a very thorough study of the habits and methods of treatment of the codling moth in cooperation with the entomologists of other Northwestern States. Much attention is given to farmers' institutes, which are supported by a legislative appropriation of $2,000 for two years, and are participated in by the members of the station staff. Institutes were held in 17 counties during the year and the attendance and interest were good.

The work of the Montana Station is well organized and is being vigorously prosecuted. The agriculturist has resigned to accept a position as animal husbandman in the Michigan College and Station and has been succeeded by F. B. Linfield, of Utah; but aside from this the organization has undergone few changes. Progress in relieving station officers of heavy teaching duties has been made, and an assistant horticulturist has been appointed with a view of developing the horticultural work in the station. A frame dairy building, costing $2,500, has been completed and considerable attention will be given henceforth to dairy investigations. The State has made several appropriations that have benefited the station, but there is great need of further appropriations for buildings and equipment.

LINES OF WORK.

The principal lines of work conducted at the Montana Station during the past year were as follows: Chemistry—study of alkali soils, alkali limit of plant growth, effect of mine tailings on vegetation, effect of various rotations on soils, sugar-beet investigations, food inspection, and miscellaneous analytical work; meteorology; botany—study of plants utilized by Indians, plants poisonous to stock, and other systematic work; field experiments—rotations, improvement of cereals, cooperative sugar-beet tests, test of grasses and forage crops; horticulture—orchard and small fruits and forest trees; feeding experiments—cattle and sheep; poultry experiments; entomology—codling moth and other insects affecting fruits, vegetables, and shade trees; irrigation—duty of water, losses by evaporation, seepage, methods of application, study of water rights, and plant and pot experiments to determine the water requirements of plants and methods of application.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	825.09
Farm products	4,183.61
Total	20,008.70

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 30–34. Bulletin 32 is the Annual Report of the station for the year ended June 30, 1901, including brief reports from the different departments and records of some of the investigations. The other subjects treated of in the bulletins are weeds of Montana, grazing and feeding tests, sugar beets in Montana, and farmers' weirs.

NEBRASKA.

Agricultural Experiment Station of Nebraska, *Lincoln.*

Department of the University of Nebraska.

GOVERNING BOARD.

Regents of the University: George F. Kenower (*President*), *Wisner;* E. von Forell, *Kearney;* Carl J. Ernst, *Lincoln;* Elisha C. Calkins, *Kearney;* Edson C. Rich, *Omaha;* John L. Teeters, *Lincoln.*

STATION STAFF.

E. A. Burnett, B. S., *Director; Animal Husbandman.*
T. L. Lyon, B. S. A., *Associate Director; Agriculturist.*
H. H. Nicholson, M. A., *Chemist.*
C. E. Bessey, Ph. D., *Botanist.*
Lawrence Bruner, B. S., *Entomologist.*
E. H. Barbour, Ph. D., *Geologist.*
A. T. Peters, D. V. M., *Animal Pathologist.*
G. D. Sweezy, M. A., *Meteorologist.*
O. V. P. Stout, C. E., *Irrigation Engineer.*
Samuel Avery, Ph. D., *Chemistry.*
R. A. Emerson, B. S., *Horticulturist.*
A. L. Haecker, B. S., *Dairy Husbandman.*
J. H. Gain, M. D. C., *Assistant in Animal Pathology.*
H. R. Smith, B. S., *Assistant in Animal Husbandry.*
S. W. Perin, *Farm Foreman.*
J. S. Dales, M. Ph., *Financial Secretary.*
W. W. Marshall, *Executive Clerk.*

GENERAL OUTLOOK.

One of the special features of the work of the Nebraska Station during the past fiscal year has been an investigation of sorghum poisoning of cattle and of the cornstalk disease, in which the departments of animal pathology, botany, and chemistry have cooperated. In studying sorghum poisoning of cattle prussic acid in sufficient quantities to cause death has been found in sorghum and in Kafir corn during certain stages of growth. The investigation of the cornstalk disease has been conducted under a special appropriation of $2,500 from the State, and one of the results of the work has been to find nitrate of potash in abnormal quantities in the stalks where cattle had died from the cornstalk disease. The department of animal pathology has also studied dysentery in calves, abortion, dips, and methods of immunizing hogs against cholera. Some results of the investigations with dips for mange in cattle and horses and lice on hogs have been published.

The work with winter wheat, in an effort to develop varieties that will make it possible to extend the winter-wheat belt farther north, has been continued, as have other investigations in agronomy, including the investigations of problems in soil culture, rotation of crops, improvement of forage crops and cereals. The relative value of different kinds of rough feed is engaging the attention of the departments of animal husbandry and dairying. Considerable progress has been made in the improvement of the sand cherry by selection, and it is also being tested as a stock upon which to bud stone fruits. An attempt is being made to produce new varieties of apples that will have better keeping qualities than those now grown and will not ripen prematurely during hot autumn weather. To this end hybridizations were made with the common apple, the Siberian crab, and the western wild crab.

The departments of agriculture and horticulture, in cooperation with farmers, have conducted a large number of experiments upon deep and

shallow plowing of corn, tests of mulches in the garden, and tests of varieties of winter wheat in different parts of the State. The station is distributing blackleg vaccine, grasshopper fungus disease, and seeds sent out by this Department, and is cooperating with this Office in irrigation investigations and with the Bureau of Plant Industry of this Department in determining the influence of environment on plants and in testing grasses and forage plants for meadows and pastures.

Farmers' institutes are conducted under the management of the director of the station and are supported by a State appropriation of $3,000 per annum. Several members of the station staff take part in institute work, and the station has thus been brought into closer relation with the various agricultural organizations of the State. The staff of the station has been strengthened by the appointment of a dairy husbandman and assistants to the agriculturist and the animal husbandman.

LINES OF WORK.

The principal lines of work conducted at the Nebraska Station during the past year were as follows: Chemistry; botany; meteorology; soils—sources of moisture, moisture as affected by different crops, aeration, and fertilization; field experiments—rotations, grasses and legumes, sugar beets, winter wheat, corn, soy beans, and imported grains; horticulture—development of hardy varieties of fruits by hybridization, grafting, and selection; diseases of plants; forestry; feeding and breeding experiments; diseases of animals—cholera in hogs, dysentery in calves, abortion, mange, sorghum poisoning, cornstalk disease; entomology—grasshopper fungus disease, chinch-bug disease; irrigation—records of water used on different crops, methods of cultivation, and records of discharge of several rivers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	4,613.18
Balance from previous year	983.56
Total	20,596.74

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 71–74 and the Annual Report for 1900. These bulletins give records of sheep-feeding experiments in Nebraska, experiments

in the culture of sugar beets in Nebraska, the adaptation and improvement of winter wheat with a view to extending the winter-wheat belt farther north, and the use of dips in eradicating mange in cattle and horses, and lice on hogs. The bulletin giving a report on dips contains illustrations of a number of dipping tanks, and gives the results of experiments with different kinds of dips.

NEVADA.

Nevada Agricultural Experiment Station, *Reno.*

Department of Nevada State University.

GOVERNING BOARD.

J. N. Evans (*President*), *Reno;* W. E. F. Deal, *Virginia City;* W. W. Booher, *Elko.*

STATION STAFF.

Joseph E. Stubbs, M. A., D. D., *Director.*
Nathaniel E. Wilson, M. S., *Chemist.*
Peter Fransden, B. A., *Zoologist, Bacteriologist.*
P. Beveridge Kennedy, *Botanist, Horticulturist.*
G. H. True, B. S., *Animal Husbandman.*
Elizabeth S. Stubbs, *Stenographer.*
Samuel B. Doten, *Entomologist.*
C. R. Fitzmaurice, *Assistant Chemist*
Theodore Clark, *Farm Foreman.*
H. H. Dexter, B. A., *Librarian.*

GENERAL OUTLOOK.

The work of the Nevada Station has been continued along the same general lines as heretofore. However, the botanist and entomologist of the station have made an extended survey of the ranges of western Nevada, studying plants eaten by sheep, and have published a preliminary report on this work. It is planned to extend this survey over the eastern part of the State and also to fence a portion of the range near Reno and study there a number of the problems concerning the improvement of ranges. Cooperation with this Office in irrigation investigations has been continued. A residence for the foreman has been built on the station farm and a $12,000 chemical building to replace the one destroyed by fire two years ago is nearing completion. This building will contain a separate dairy room, a chemical laboratory, photographic room, and other accommodations for the station. It will also relieve the crowded condition in the old station building.

Interest in the station is growing, especially among irrigators and ranchmen. A farmers' institute has been held at Elko, to which some ranchmen rode 50 or 60 miles. G. H. True, of the Arizona Station, has been elected animal husbandman, to take charge of the work January 1, 1903. Animal husbandry is an industry which needs to be built up in the State, and it is hoped that the establishment of a department in charge of animal husbandry at the station will materially aid in the development of this industry.

LINES OF WORK.

The principal lines of work conducted at the Nevada Station during the past year were as follows: Botany—study of range plants eaten by sheep; soils; field experiments—tests of varieties of wheat, grasses, and other forage plants, experiments with different quantities of seed and with barnyard manure; horticulture; forestry; animal diseases; entomology; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	598.49
Balance from previous year	432.57
Total	16,031.06

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

No publications were received from this station during the past fiscal year.

NEW HAMPSHIRE.

New Hampshire College Agricultural Experiment Station, *Durham.*

Department of New Hampshire College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Control: John G. Tallant (*Chairman*), *Pembroke;* Henry W. Keyes, *Haverhill;* George A. Wason, *New Boston;* Charles W. Stone (*Secretary*), *Andover;* Charles S. Murkland (*President*), *Durham.*

STATION STAFF.

Fred W. Morse, M. S., *Vice-Director; Chemist.*
Charles H. Pettee, M. A., C. E., *Meteorologist.*
Herbert H. Lamson, M. D., *Bacteriologist.*
Clarence M. Weed, D. Sc., *Entomologist.*
Frank Wm. Rane, B. Agr., M. S., *Horticulturist.*
A. L. Sullivan, B. S., *Assistant Chemist.*
Lucien A Hill, B. S., *Assistant Chemist.*
A. F. Conradi, *Assistant Entomologist.*
Frederick C. Keith, *Clerk.*
H. M. Tucker, *Assistant in Dairy Husbandry.*
Harry F. Hall, *Gardener.*

GENERAL OUTLOOK.

In most departments the work of the New Hampshire Station has been essentially a continuation of lines previously undertaken. A change in the head of the agricultural department resulted in closing most of the work in that department and beginning new investigations, emphasis being laid on experiments to discover varieties of corn

suited to the climate, and experiments to find a cheap way to restore fertility to depleted soils without the use of commercial fertilizers. One of the most important features of the station work for the past year has been the joint study by the horticulturist, bacteriologist, and chemist of problems relating to the cold storage of apples, including the influence of cold storage on the decay of apples, effect of wrapping apples in paper, and chemical changes in apples during storage. Much information of value to fruit growers has been obtained, and the results published. The horticulturist has a novel experiment with potatoes, growing them on soil mixed with sawdust to determine whether or not sawdust used as bedding for animals and distributed with manure is injurious to potatoes. He has continued his experiments and studies with muskmelons and has published a classification of the American sorts, grouping them into eight types, based on the size and shape of the fruit, and named after the most widely known and characteristic variety within the type. The entomologist, in addition to his work with insects, has been giving considerable attention to nature study, and is chairman of the nature-study committee which has prepared an outline course in nature study and drawing for the New Hampshire schools, which has been adopted by the State Teachers' Association. The station is cooperating with the Bureau of Plant Industry of this Department in studying the influence of the origin of red clover seed on yield of crop, in tests of novelties introduced by the seed trade, and continues to cooperate with the State board of agriculture in the inspection of fertilizers and feeding stuffs. A new agricultural building (Pl. III, fig. 2), for which the legislature appropriated $30,000, is nearing completion. It will furnish offices for the agriculturist and horticulturist of the station and a bulletin mailing room. Since the close of the year the director and agriculturist elected January 1, 1902, has resigned to accept a position in the Texas College and Station, and the vice-director is now executive officer of the station.

The New Hampshire Station has in hand a large amount of work closely related to the trucking, fruit growing, and other agricultural interests of the State, but work in the agricultural department unfortunately has been interrupted several times by changes in the staff.

LINES OF WORK.

The principal lines of work conducted at the New Hampshire Station during the past year were as follows: Chemistry—study of yield of dry matter and digestible nutrients in corn and hay, loss of nutrients in corn fodder under different methods of storing; analysis of fertilizers and feeding stuffs; bacteriology—study of bacteria and fungi causing changes in silage, decay of fruits in cold storage, etc.; soil physics—draft and efficiency tests of surface-working implements;

field experiments—crop rotations, variety tests of early corn; horticulture—tests of varieties of muskmelons, potatoes, strawberries, tomatoes, and other fruits and vegetables, experiments in forcing vegetables, renovation of old orchards; diseases of plants—study of the life history and methods of preventing diseases of apples, cucumbers, melons, and other fruits and vegetables; feeding experiments—test of the comparative feeding value of corn meal and corn-and-cob meal in milk production, and of timothy hay, clover hay, and corn stover for the same purpose; entomology—suppression of insect pests and a study of the life zones of the principal insects of the State.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	592.50
Total	15,592.50

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 80–90 on the following subjects: The inspection of fertilizers in 1900; insect record for 1900; feeding farm horses; the value of meadow muck; forcing dwarf tomatoes under glass; remedies for the cankerworm; growing watermelons in the North; classification of watermelons; Annual Report for 1901; inspection of fertilizers in 1901; the squash bug; and insect record for 1901. Also Technical Bulletins 1–3 on the following subjects: An annotated catalogue of the butterflies of New Hampshire; the classification of American muskmelons; and the food of the myrtle warbler.

NEW JERSEY.

New Jersey State Agricultural Experiment Station, *New Brunswick.*

At Rutgers College.

GOVERNING BOARD.

Board of Managers: Gov. Franklin Murphy, *Trenton;* Austin Scott, *New Brunswick;* Edward B. Voorhees, *New Brunswick;* Ephraim T. Gill, *Haddonfield;* Robert Gwynne, *Salem;* Winfield S. Bonham, *Shiloh;* John E. Darnell, *Masonville;* David D. Denise (*President*), *Freehold;* James Neilson, *New Brunswick;* Samuel B. Ketcham (*Vice-President*), *Pennington;* George Fritts, *Pattenburg;* Josiah Ketcham, *Belvidere;* James A. Burnett, *Hilton;* Abram C. Holdrum, *Westwood;* George H. Blakeley, *Paterson;* George E. De Camp, *Roseland;* Cyrus B. Crane, *Caldwell;* George Dorer, *East*

Orange; Ira C. Kilburn, *South Orange;* Rynier J. Wortendyke, *Jersey City;* Lucius F. Donohoe, *Bayonne;* John B. Williams, *New Durham;* Philip M. Brett, *Jersey City.*

STATION STAFF.

Edward B. Voorhees, D. Sc., *Director.*
Irving S. Upson, M. A., *Chief Clerk, Secretary, Treasurer.*
Louis A. Voorhees, M. A., *Chief Chemist.*
John P. Street, M. S., *Associate Chemist.*
Alva T. Jordan, B. S., *Assistant Horticulturist.*
Clarence B. Lane, B. S., *Assistant in Dairy Husbandry.*
Jacob G. Lipman, *Soil Chemist, Bacteriologist.*
William P. Allen, B. S., *Assistant Chemist.*
John B. Smith, D. S., *Entomologist.*
Mary A. Whitaker, *Stenographer and Typewriter.*
Vincent J. Carberry, *Laboratory Assistant.*
Harry W. Williams, *Janitor.*

New Jersey Agricultural College Experiment Station, *New Brunswick.*

Department of Rutgers College.

GOVERNING BOARD.

Board of Trustees—Executive Committee: Austin Scott (*Chairman*), *New Brunswick;* Henry W. Bookstaver, *24 East Sixty-fourth street, New York City;* James Neilson, *New Brunswick;* Paul Cook, *Troy, N. Y.;* Wm. H. Leupp, *New Brunswick;* John W. Herbert, jr., *Helmetta.*

STATION STAFF.

Edward B. Voorhees, D. Sc., *Director.*
Julius Nelson, Ph. D., *Biologist.*
Byron D. Halsted, D. Sc., *Botanist, Horticulturist.*
John B. Smith, D. Sc., *Entomologist.*
James A. Kelsey, M. S., *Field Assistant.*
Irving S. Upson, M. A., *Disbursing Clerk, Librarian.*
Augusta E. Meske, *Stenographer and Typewriter.*

GENERAL OUTLOOK.

The New Jersey State and College stations continue to be under the same director and to issue their publications in one series. Their work during the past year has included several new and valuable features, notable among which are the studies of mosquitoes; the studies of soil bacteria; the investigations of the adulterants of feeding stuffs; the work in oyster culture, with a small State appropriation; the plant-breeding experiments with eggplants, sweet corn, cucumbers, and tomatoes; and the experiments in producing and utilizing forage and soiling crops. The entomologist has had an emergency fund of $1,000, with which he has made considerable progress in studying means of combating the mosquito in the State. It is thought that a good deal can be done to relieve the nuisance by draining and filling in the holes where stagnant water collects. The cooperation of the railroads has been elicited and a great interest aroused among public-spirited citizens and organizations. A special bulletin on the salt-marsh mosquito has recently been issued. The soil bacteriological laboratory is well equipped, and studies of nitrifying bacteria (not on leguminous plants) and denitrifying bacteria are in progress. The plant-breeding exper-

iments are showing good results, especially those with eggplants to secure a longer fruit, and with sweet corn to secure a more prolific variety. The farm is run largely as a demonstration farm, taking advantage of the opportunity to make a great variety of experiments and tests. About fifty head of cattle are kept and about $6,000 worth of milk is sold every year. A number of heifers are being raised as a part of the experiment in breeding up a dairy herd. The stations are giving useful demonstration of what can be done in intensive farming and the large amount of stock which can be kept on a relatively small area, also in supplying protein in the form of alfalfa and other legumes in place of buying bran and other expensive feeds, and at the same time are showing how the soil fertility may be maintained or increased under a proper system of management. The stations are cooperating with the Bureau of Soils of this Department in a soil survey, and with this Office in irrigation investigations. The State appropriation for printing has been increased $500 this year, making a total of $1,500.

The great problem that the New Jersey stations have been trying to solve for several years has been the introduction throughout the State of intensive and specialized agriculture in place of general farming, and in the solution of this problem they are succeeding admirably.

As a result of their investigations and advice the trucking interests of the State have grown enormously, and organizations of farmers have been formed in the truck-growing districts for the purchase of unmixed fertilizing materials, thus effecting a saving of from 25 to 40 per cent in the cost of fertilizers and at the same time securing better results as regards earliness of yield and quality of product. Such work as this and the results attained are bringing the stations into close touch with the people of the State. The extension of the soil investigations to include biological studies of the soil strengthens the work materially at a point where there should be more study.

LINES OF WORK.

The principal lines of work conducted at the New Jersey stations during the past year were as follows: Chemistry—study of adulterants of feeding stuffs, methods of examining insecticides, studies of the losses of nitrogen in barnyard manures; biology—oyster culture; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments—forage crops, soiling crops, experiments with fertilizers and garden crops, experiments with barnyard manures; horticulture—culture experiments with orchard and small fruits, ornamentals, and vegetables, cross fertilization of eggplants, sweet corn, cucumbers, and tomatoes; diseases of plants—diseases of beans, potatoes, sweet potatoes, and other garden vegetables; food and nutrition of man; diseases of animals; entomology—study of mosquitoes and methods of eradicating them, study of the rose scale, orchard insects,

and the use of insecticides; dairy husbandry—breeding up a dairy herd, study of domestic pasteurizing methods and the care of milk in the home, feeding dairy cows, including the investigation of legumes as substitutes for purchased feeds; bacteria of soils; and irrigation.

INCOME.

The income of the stations during the past fiscal year was as follows:

State Station: State appropriation (fiscal year ended October 31, 1902)	$20,000.00
College Station: United States appropriation	15,000.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of these stations received during the past fiscal year were Bulletins 150–156, and the Annual Report for 1900. Bulletin 150 is divided into three parts, devoted, respectively, to losses in farm manures, the relative usefulness of the nitrogen in fresh and in leached manures, and the comparative value of the nitrogen in commercial forms and in natural manures. The other bulletins are on the following subjects: Bean diseases and their remedies, domestic pasteurizing methods and the care of milk in the home, concentrated feeding stuffs, analyses of commercial fertilizers, the entomologist's experiment orchard, cattle-food substitutes, and a warning to feeders.

NEW MEXICO.

Agricultural Experiment Station of New Mexico, *Mesilla Park.*

Department of New Mexico College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Regents: Granville A. Richardson (*President*), *Roswell;* H. B. Holt (*Secretary and Treasurer*), *Lascruces;* Seaman Field, *Deming;* W. A. Cooper, *Santa Fe;* Jose Lucero, *Lascruces.* Advisory Members: Gov. Miguel A. Otero, *Santa Fe;* J. Francisco Chaves (*Superintendent of Public Instruction*), *Santa Fe.*

STATION STAFF.

Luther Foster, M. S. A., *Director.*
Arthur Goss, M. S., A. C., *Chemist.*
John J. Vernon, M. S. Agr., *Agriculturist.*
E. O. Wooton, M. A., *Botanist.*
John D. Tinsley, B. S., *Vice-Director; Soils and Meteorology.*
Fabian Garcia, B. S., *Horticulturist.*
R. Fred Hare, M. S., *Assistant Chemist.*
Charles L. Post, M. S., *Assistant Chemist.*
Henry C. McLallen, M. S. Agr., *Assistant Agriculturist.*
Francis E. Lester, *Registrar.*
Pinckney Ford, *Stenographer.*

GENERAL OUTLOOK.

During the past fiscal year the New Mexico Station has continued its investigations along nearly the same lines as formerly, but considerable progress has been made in definitely outlining and systematizing the work so that several of the problems can be attacked from different points of view. In general, the problems under consideration are those of the arid region—animal husbandry and the production of forage crops, pasture, cereals, and fruits under irrigation. One of the most important investigations undertaken since the organization of the station, that of irrigating by pumping from wells, was inaugurated during the past year. This work, so far as it has been carried on, shows that in the Mesilla Valley, at least, the amount of underground water available is much greater than has previously been considered possible. This water is of good quality for irrigation and is reached at a depth of 20 feet and lower. A well 6 inches in diameter and 48 feet deep yielded a steady flow of a little more than 800 gallons a minute for a continuous run of thirty hours, with no apparent diminution of the available supply. Using wood at a cost of $2.25 per cord, it was found that the expense of irrigating land with an amount of water sufficient to cover 3 inches deep was about 58½ cents an acre. While the work is at present only in its beginning, it bids fair to bring large areas of fertile land into cultivation, not only in the Rio Grande, but in numerous other valleys of the Territory where water for irrigation is scarce.

The station is cooperating with the Bureau of Plant Industry of this Department in testing crops for supplying forage to supplement the natural ranges, and for the improvement of cultivated lands; with the Bureau of Chemistry, in studying available plant food in soils; with the Bureau of Soils, in making a soil survey; and with this Office, in irrigation investigations.

But few changes in the staff occurred during the past year. The positions of assistant botanist and consulting entomologist were discontinued, and those of second assistant chemist and assistant in agriculture were created, and appointments made to fill them. An adobe corral, 160 by 200 feet, with sheds around the outside for sheltering tools, implements, and stock, and for storing hay and grain, was completed at a cost of $3,000; and complete equipment was supplied for making extensive investigations in irrigation by pumping from wells.

The staff of the New Mexico station has now established a settled policy in station work, and the heads of the departments have been long enough in charge of their especial lines to become familiar with the conditions existing in the Territory and the more urgent needs

of those engaged in the different lines of farming. These conditions, and the fact that the station is coming into closer touch with the people of the Territory, put it in a better position for carrying on work of investigation and for making it of lasting benefit to the Territory than at any previous time in its history.

LINES OF WORK.

The principal lines of work conducted at the New Mexico Station during the past year were as follows: Chemistry—chemical survey of the waters of the Territory, analytical work, study of the ash of native plants; field experiments—alfalfa, grasses for lawns and pastures, cereals, soil renovators, forage crops; soils; feeding experiments with dairy cows, steers, and sheep to test the value of various grains and forage crops for soiling and for dry feed; horticulture—culture, pruning, spraying, and irrigation of orchard, vineyard, and small fruits, vegetable culture, tests of shrubs, flowers, and forage trees; botany—preparation of botanical map of the Territory, range problems; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,115.42
Total	16,115.42

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 38–40 and the Annual Report for 1901. The subjects upon which bulletins have been published are soil and soil-moisture investigations for the season of 1900, orchard notes, and a southern New Mexico flower garden.

NEW YORK.

New York Agricultural Experiment Station, *Geneva.*

Board of Control: Stephen H. Hammond (*President*), *Geneva;* W. O'Hanlon (*Secretary and Treasurer*), *Geneva;* Gov. Benj. B. Odell, jr., *Albany;* Jens Jensen, *Binghamton;* Thos. B. Wilson, *Halls;* F. C. Schraub, *Lowville;* E. A. Callahan, *Albany;* Edgar G. Dusenbury, *Portville;* Oscar H. Hale, *North Stockholm;* Martin L. Allen, *Fayette;* Lyman P. Haviland, *Camden.*

STATION STAFF.

W. H. Jordan, D. Sc., *Director.*
Geo. W. Churchill, *Agriculturist, Superintendent of Labor.*
Wm. P. Wheeler, *Animal Industry.*
H. A. Harding, B. S., *Bacteriologist.*
John F. Nicholson, B. S., *Assistant Bacteriologist.*
F. C. Stewart, M. S., *Botanist.*
H. J. Eustace, B. S., *Assistant Botanist.*
L. L. Van Slyke, Ph. D., *Chemist.*
C. G. Jenter,[a] Ph. C., *Assistant Chemist.*
W. H. Andrews, B. S., *Assistant Chemist.*
Fred D. Fuller, B. S., *Assistant Chemist.*
Chas. W. Mudge, B. S., *Assistant Chemist.*
E. B. Hart, B. S., *Assistant Chemist.*
Andrew J. Patten,[a] B. S., *Assistant Chemist.*
George A. Smith, *Dairy Expert.*
Frank H. Hall, B. S., *Editor and Librarian.*
Victor H. Lowe, M. S., *Entomologist.*
H. O. Woodworth, M. S., *Assistant Entomologist.*
S. A. Beach, M. S., *Horticulturist.*
Vinton A. Clark, B. S., *Assistant Horticulturist.*
O. M. Taylor, *Foreman in Horticulture.*
F. E. Newton, *Clerk and Stenographer.*
Jennie Terwilliger, *Clerk and Stenographer.*
A. H. Horton, *Computor.*

GENERAL OUTLOOK.

The New York State Station has continued its investigations along lines closely related to a few of the leading industries of the State. These are dairying, including cheese making; fruit raising; poultry raising, and plant production, including both field crops and garden vegetables, with closely related investigations on insects and diseases affecting fruits and plants. It has made progress in the study of changes in the ripening of cheese and their causes, and in the keeping of cheese in cold storage, for which an excellent equipment in the way of apparatus and a series of rooms well regulated in temperature is provided. Important results have been reached during the year, and the published account of these is of great interest. A part of this work has been done in cooperation with the Bureau of Animal Industry of this Department. The station is also cooperating with the Bureau of Chemistry in sugar-beet investigations, and with the Bureau of Plant Industry in growing sugar-beet seed. Cooperative work with farmers and others has been carried on in more than twenty localities, the tests involved in such cooperation being those upon grape fertility, grape stocks, apple stocks, shading strawberries, growing chestnuts, apple storage, spraying potatoes, treatment of cabbage diseases, repression of San José scale and woolly aphis, growing forage crops, and treatment of cheese faults.

The station met with a great temporary loss during the year in the destruction of its barns by fire. These are being partially rebuilt with insurance money, and will provide better facilities than heretofore. The residence of the director has been completed and the former residence and office building is being entirely remodeled for an administration building and library. The branch office on Long Island has been given up, but work will be continued there.

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[a] On leave.

The work of the New York State Station is efficiently conducted in all its departments. The generous funds at its disposal, together with the fact that its staff has no teaching to do, enable it to carry on work in a very thorough manner. No pains are spared in the execution of details or recording of results. It is making an excellent showing, and while it is attracting attention to itself as a thoroughly scientific institution, it is also doing work which appeals to the people of the State, and is planned directly for their benefit. The popular editions of its bulletins are very well received in the State, and the wisdom of the plan of issuing them is abundantly demonstrated to the minds of the officers in charge of the work. A paper on this feature of the station publications is given on page 481.

LINES OF WORK.

The principal lines of work conducted at the New York State Station during the past year were as follows: Chemistry—study of problems in cheese ripening; bacteriology—study of problems in cheese ripening, tests of methods for the repression of rusty spot in cheese; meteorology; fertilizers—study of the proportions and forms of fertilizing ingredients best suited to the staple crops of the State; analysis and control of fertilizers; inspection of creamery glassware; field experiments—test of commercial fertilizers and stable manure on crops in rotation, study of crops grown on soils treated with crude chemicals, and cooperative tests of forage and soil-renovating crops, variety tests of cowpeas and wheat, growth of mother beets to test the possibility of raising sugar-beet seed; horticulture—study of the cause and effect of self-sterility among grapes, effect of fertilizers on the quality of strawberries and bush fruits, tests of various stocks for native grapes and for dwarf apples, comparison of American and Japanese chestnuts, use of screens for shading strawberries, experiments with apples in cold storage, breeding of grapes, raspberries, currants, gooseberries, and strawberries, test of lettuce, fertilizers in greenhouse, systems of fertilizing an apple orchard, study of forcing tomatoes with reference to frequency of pollination required, collection of data to determine the significance of correlation of parts as a factor in plant breeding; diseases of plants—investigations and experiments in the treatment of raspberry and blackberry diseases, especially cane blight, inauguration of a ten-year test of the efficiency of spraying potatoes to prevent disease and to increase yield, test of repressive measures for black rot of cabbage and cauliflower, with investigation of soft rot of the same plants, study of Rhizoctonia as a cause of plant diseases; feeding experiments; poultry experiments—study of the effect and value of different classes of nutrients in poultry feeding and of inbreeding and selection as affecting egg production; entomology—

biological study of the San José scale and the development of a successful and convenient method for controlling this insect, experiments on the fertilization of fruit by bees, study of the economic relations of Dactylopius; dairying; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$1,500.00
State appropriation	74,847.55
Insurance	5,558.97
Total	81,906.52

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were the Annual Report for 1900, containing reports from the different departments, and Bulletins 197–212, on the following subjects: The food sources of milk fat, with studies on the nutrition of milch cows (and a popular edition); inspection of feeding stuffs, 1900–1901; an epidemic of currant anthracnose (and a popular edition); notes from the botanical department (and a popular edition); report of analyses of commercial fertilizers for the spring and fall of 1901; San José scale investigations (and a popular edition); a study of enzyms in cheese (and a popular edition); report of analyses of Paris green and other insecticides in 1901; influence of manure upon sugar beets (and a popular edition); commercial fertilizers for onions (and a popular edition); conditions affecting weight lost by cheese in curing (and a popular edition); stable manure and nitrogenous chemical fertilizers for forcing lettuce (and a popular edition); treatment for San José scale in orchards—I. Orchard fumigation; the immediate effect on milk production of changes in the ration (and a popular edition); director's report for 1901; and miscellaneous notes on injurious insects (and a popular edition).

Cornell University Agricultural Experiment Station, *Ithaca*.

Department of Cornell University.

GOVERNING BOARD.

STATION STAFF.

Isaac P. Roberts, M. Agr., *Director; Agriculturist.*
George C. Caldwell, B. S., Ph. D., *Chemist.*
James Law, F. R. C. V. S., *Veterinarian.*
John H. Comstock, B. S., *Entomologist.*
Liberty H. Bailey, M. S., *Horticulturist.*
Henry H. Wing, B. Agr., M. S., *Dairy Husbandry, Animal Industry.*
G. F. Atkinson, M. S., *Cryptogamic Botanist.*
John Craig, M. S., *Extension Work in Agriculture and Horticulture.*
Mark V. Slingerland, B. S., *Assistant Entomologist.*
George W. Cavanaugh, B. S. A., *Assistant Chemist.*
John W. Gilmore, B. S. A., *Agriculturist.*
Clayton O. Smith, B. S., *Assistant in Cryptogamic Botany.*
Jas. A. Foord, B. S. A., M. S., *Assistant in Dairy Husbandry.*
Chas. E. Hunn, *Gardener.*
G. W. Tailby, *Farm Foreman.*
E. L. Williams, *Treasurer.*
E. A. Butler, *Clerk.*
Lizzie V. Maloney, *Stenographer.*

GENERAL OUTLOOK.

The New York Cornell Station has continued its investigations along nearly the same lines as heretofore. The problems attacked are largely those of immediate practical concern to the people of the State. Such are the tillage, fertilizer, and spraying experiments, a study of the effect of feed in increasing the fat content of the milk of poorly fed cows, a test of cover crops for orchards, the renovation of old orchards, and several other lines of work. On the other hand, some attention is given to the investigation of unsolved problems requiring more thorough and long-continued research. The cryptogamic botanist has undertaken an interesting study regarding the place occupied by mushrooms in the cycle of plant life and will try to answer the question, Does the mushroom elaborate food from dead wood and render it available for growing plants. The station is cooperating with the Bureau of Chemistry of this Department in sugar-beet investigations, and has continued to carry on an extensive system of cooperative experiments throughout the State with the aid of State funds. At the close of the year the assistant agriculturist resigned to accept a position in the Connecticut Storrs College and Station.

The extension work of the Cornell University and Station, supported by a State appropriation of $35,000 per annum, is a strong factor in bringing the results of experiments into practical use among the people and is exerting a marked influence on the schools as well as the home life of the rural population. This work now comprises cooperative experiments with numerous farmers in all parts of the State, and the publication and free distribution of Reading Lessons for Farmers and Reading Lessons for Farmers' Wives, which serve the purpose of correspondence instruction for adults, and similar work for school children through the Junior Naturalist Monthly, which, together with numerous circular letters, is sent to about 18,000 members of Junior Naturalist clubs. A detailed account of the cooperative enterprises of the Cornell Station is given on page 516.

LINES OF WORK.

The principal lines of work conducted at the Cornell Station during the past year were as follows: Chemistry—study of soils, feeding stuffs, dairy products, insecticides, causes of injury to foliage by Bordeaux mixture; fertilizers; field experiments—tests of rotations, legumes, and fertilizers, tillage and fertilizer experiments with potatoes, beans, buckwheat, etc., plat experiments with grasses; horticulture—forcing strawberries, tree fruits, and mushrooms, studies of Japanese plums and methods of spraying; diseases of plants—fungus diseases of forest and shade trees, study of the rôle of fungi in rendering available the plant food in dead wood, study of edible fungi and of numerous fungus and bacterial diseases of vegetables; feeding experiments—dairy cows, sheep, and swine; diseases of animals; poultry experiments—crossing of breeds, experiments in the cost of egg production and on the effect of early moulting on laying in the early fall and winter; entomology—study of the life history of several economic insects, spraying experiments; and dairying—relation of feed to fat content of milk, bacteriological study of the germicidal action in milk, study of fermentation in condensed milk.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$13,500.00
State appropriation	[a]12,666.67
Farm products, including balance from previous year	583.21
Miscellaneous, including balance from previous year	538.56
Total	27,288.44

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 193–201 and the Annual Report for 1901. The Annual Report contains brief reports from the different departments of the station, and the bulletins include the following subjects: Studies of some shade-tree and timber destroying fungi, the Hessian fly—its ravages in New York in 1901, further observations upon ropiness in milk and cream, fourth report on potato culture, investigations concerning the germicidal action in cow's milk, orchard cover crops, separator-skimmed milk as food for pigs, muskmelons, and buying and using commercial fertilizers.

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[a] This is approximately the amount spent for experimental purposes out of an appropriation of $35,000 by the State for cooperative experiments and university extension work in agriculture.

NORTH CAROLINA.

North Carolina Agricultural Experiment Station, *West Raleigh.*

Department of North Carolina College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

S. L. Patterson, *Commissioner of Agriculture, Chairman.*

Board of Agriculture: J. B. Coffield, *Everetts*; E. L. Daughtridge, *Rockymount;* Wiliam Dunn, *Newbern;* C. N. Allen, *Auburn;* J. S. Cunningham, *Cunningham;* A. T. McCallum, *Red Springs;* J. P. McRae, *Laurinburg;* W. A. Graham, *Machpelah;* A. Cannon, *Horseshoe;* J. R. Joyce, *Reidsville;* G. E. Flow, *Monroe;* J. C. Ray, *Boone;* Howard Browning, *Littleton.*

STATION STAFF.

B. W. Kilgore, M. S., *Director.*
W. A. Withers, M. A., *Chemist.*
C. W. Burkett, M. S., Ph. D., *Agriculturist.*
W. F. Massey, C. E., *Horticulturist.*
Tait Butler, V. S., *Veterinarian.*
Franklin Sherman, jr., B. S. A., *Entomologist.*
A. F. Bowen, *Bursar.*
F. L. Stevens, M. S., Ph. D., *Biologist.*
G. S. Fraps, Ph. D., *Assistant Chemist.*
J. C. Kendall, B. S., *Assistant in Dairying; Poultryman.*
B. S. Skinner, *Farm Superintendent.*
B. F. Walton, *Superintendent Agricultural Experimental Work.*

GENERAL OUTLOOK.

The North Carolina Station has continued lines of work formerly in progress, and during the year has inaugurated considerable new work in agronomy and animal husbandry, including experiments in breeding and handling beef cattle and similar experiments with poultry. Much progress has been made in reorganizing this station under the control of the State board of agriculture, with a director who is independent of the other departments of the college. The new arrangement seems to work admirably. The station conducts experiments of a scientific nature and the State department of agriculture tests the results in a practical way on its farms, of which two were purchased last year—one at each end of the coastal plain section of the State, and one has been acquired recently on the red clay lands in the Piedmont region. The State department of agriculture also conducts the inspection work in entomology and pays for the work with Texas fever, in which a system of inspectors is employed, and work in immunizing cattle for private individuals is done. Of the income of the department from the fertilizer tax last year about $5,000 has been devoted to experimental purposes. A herd of Aberdeen Angus cattle has been purchased, part of which will be used by the station and part by the department. The station poultry now comprises 160 hens, with which the poultryman has been testing cotton-seed meal, milk albumen, poultry tonics, and condimental feeds. Much larger flocks will be secured and attempts will be made to demonstrate that poultry raising is profitable on a large scale. The horticulturist of the station continues to direct considerable effort to the encouragement

of producing early truck crops, bulbs, and flowers for the northern market. The station is cooperating with the Bureau of Plant Industry of this Department in testing grasses and forage plants for meadows and pastures, and with the Bureau of Chemistry in studying the available plant food in soils and the influence of environment on the sugar content of muskmelons.

Systematic and vigorous efforts are being made to bring the results of the station work before the farmers through farmers' institute work and the various publications of the station and the State department of agriculture. These efforts have been conducted with good results throughout the State, as have also the efforts to arouse interest in agricultural education. The work which has been done under the present director and the general condition of station affairs have abundantly demonstrated the usefulness of an administrative officer who can devote his time largely to the station work. The existing cordial relations between the station, the State department of agriculture, and the college are very encouraging for the future success of the station.

LINES OF WORK.

The principal lines of work conducted at the North Carolina Station during the past year were as follows: Chemistry—rate of nitrification of different nitrogenous substances in different soils, methods of analysis; soils; field experiments—variety, cultural, and fertilizer tests with cotton, corn, and cowpeas, experiments with grasses and forage plants; horticulture—experiments with orchard fruits and in growing truck crops, bulbs, and flowers for northern markets; plant diseases; animal husbandry—beef production, feeding work horses; diseases of animals; poultry experiments; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	[a] 5,000.00
Farm products	199.73
Total	20,199.73

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 179, on the composition of cotton-seed meal, and Bulletin 180, on the sugar beet in North Carolina.

[a] Approximate amount spent for experimental purposes.

NORTH DAKOTA.

North Dakota Agricultural Experiment Station, *Agricultural College.*[a]

Department of North Dakota Agricultural College.

GOVERNING BOARD.

STATION STAFF.

J. H. Worst, LL. D., *Director.*
E. F. Ladd, B. S., *Chemist.*
J. H. Shepperd, M. S. A., *Agriculturist.*
C. B. Waldron, B. S., *Horticulturist.*
H. L. Bolley, M. S., *Botanist.*
H. M. Ash, *Farm Superintendent.*
C. E. Nugent, *Bookkeeper and Accountant.*

GENERAL OUTLOOK.

Problems in agronomy, such as the improvement of methods of cultivation and the development, acclimatization, and distribution of hardy varieties of cereals, forage plants, and fruits, have continued to occupy a prominent position in the investigations of the North Dakota station. Plant breeding and selection have been the principal methods employed for securing varieties suited to the climate of the State. Among the newer plants which have been demonstrated to be well adapted to certain portions of the State are maccaroni wheats and emmer. Flax growing is an important industry in the State, but is seriously menaced by the prevalence of flax wilt and flax-sick soils. The station, as a result of its experiments, has been able to demonstrate the nature and cause of this disease and to suggest methods of treatment. It has been found that flax wilt is due to the action of parasitic fungi and that the continuous culture of flax on the same soil results in the latter becoming flax sick. When a soil thus becomes infected the disease persists for many years without the presence of the flax. Careful treatment of the seed with formaldehyde and seeding on land not previously cropped with flax are the remedial means proposed. The botanist has devised an ingenious device for treating flax and other seeds with formaldehyde vapor.

The work in animal husbandry was seriously crippled by the loss of the barn which burned in January, 1901, but some experiments have been made in feeding horses and mules, in pasturing sheep, in fattening pigs under local conditions, etc. Two new barns, costing $18,000, have now been built—a two-story horse barn which contains a class room with a seating capacity for 125 students and is used for classes in stock judging, veterinary clinics, etc., and a two-story cow barn which has connected with it a brick silo with a capacity of 200 tons.

[a] Freight and express address, *Fargo.*

A very complete sewer system connecting with the city system has been constructed at a cost of $5,300.

The station has undertaken tests of farm machinery and proposes to give more attention to this subject in the future. It is cooperating with the Bureau of Plant Industry of this Department in the investigation of cereals, forage plants, and other crops, and in studies on the influence of origin of red clover seed on yield of crop; with the Bureau of Chemistry in studying the available plant food in soils, and with the Bureau of Soils in a soil survey. The pot experiments on the water requirements of plants in relation to the available plant food of the soil, undertaken in cooperation with this Office, are still in progress and are features of irrigation investigations which should be encouraged. Farmers' institutes are maintained by a State appropriation of $1,500 per annum and during the year were held under college management at 27 different places. The demand for work of this kind more than keeps pace with the funds appropriated.

The last legislative assembly made a small appropriation for experiments at Edgeley, and the citizens of that vicinity donated a quarter-section of land for the purpose. The efforts at this place have been devoted mainly to studies on soil moisture, tests of grasses and forage plants, and methods of cultivation.

The influence of the North Dakota Station is becoming apparent in the improved agricultural methods. The practices of crop rotation, diversified farming, and seed selection are observable throughout the State. Much of the work thus far has been confined to the consideration of the more practical problems which appeal to the farmers of the State, but it is thought that the time has now arrived when the efforts of the station should be directed more largely to the solution of problems requiring more thorough scientific investigations for their solution. In order to develop its work to keep pace with the rapid growth of agriculture in the State the station needs additional funds, which might well be used particularly for experimental investigations in animal industry and dairying.

LINES OF WORK.

The principal lines of work conducted at the North Dakota Station during the past year were as follows: Field experiments—rotations, methods of culture, tests of hardy varieties of cereals and forage plants, selection of seed, selection and improvement of potatoes, sugar beets, corn, clover, alfalfa, and other farm crops; plant breeding—cereals; horticulture—variety tests of fruits and vegetables, experiments with forest trees; analysis of foods; diseases of plants—flax wilt; animal husbandry—feeding experiments with horses, mules, sheep, and pigs, and tests of the comparative feeding value of brome grass and timothy; diseases of animals; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,959.85
Miscellaneous	966.25
Total	17,926.10

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 47–51 and the Annual Report for 1901. Bulletin 47 treats of a number of subjects, including humus and soil nitrogen; climatic studies with wheat, oats, and corn; brome and timothy compared, and Austrian brome hay. The other bulletins record wheat-farming experiments, soil-moisture studies, experiments in fruit culture and corn culture, and investigations of flax wilt and flax-sick soils, including the suggestion of remedial measures.

OHIO.

Ohio Agricultural Experiment Station, *Wooster.*

GOVERNING BOARD.

Board of Control: Alva Agee (*President*), *Cheshire;* O. E. Bradfute (*Secretary*), *Xenia;* D. L. Sampson (*Treasurer*), *Cincinnati;* F. Whittlesey, *Atwater;* D. D. White, *Castalia.*

STATION STAFF.

C. E. Thorne, M. S. A., *Director.*
W. J. Green, *Vice-Director, Horticulturist.*
C. G. Williams, *Agriculturist, Superintendent of Farm.*
A. D. Selby, B. S., *Botanist.*
John W. Ames, B. S., *Chemist.*
P. J. Parrott, M. A., *Entomologist.*
W. H. Kramer, *Bursar.*
John F. Hicks, *Assistant Botanist.*
Clarence W. Waid, B. S., *Assistant Horticulturist.*
William Holmes, *Farm Foreman.*
C. A. Patton, *Assistant Foreman, Meteorologist.*
Faye Blayney, *Mailing Clerk.*
Cary Welty, *Mechanician.*
Lewis Schultz, *Superintendent Substation* (*Swanton*).
Edward Mohn, *Superintendent Substation* (*Strongsville*).

GENERAL OUTLOOK.

The Ohio Station during the past year has continued most of the lines of work begun last year. It is no longer charged with orchard and nursery inspection, nor with the testing of animals suspected to be tuberculous, these duties having been transferred to the State board of agriculture by legislative enactment. The rotation and fertilizer

experiments with corn, oats, wheat, and potatoes have been conducted from six to fourteen years in five widely separated sections of the State, and are bringing out the peculiarities of the different soils and the feeding habits of different crops. The variety tests with cereals are bringing into use varieties of wheat that give better yields and are better in quality. Breeding experiments with corn and wheat to increase their protein content are now in progress. An attempt is being made to prevent the stomach worm in sheep while the sheep are kept on an infected pasture. Among other features of the station work are an extensive study of plums, of which the station has 175 varieties; a study of a troublesome disease of ginseng, and an experiment in the care of manure. The station is cooperating with the Bureau of Plant Industry of this Department in studying the influence of the origin of red-clover seed on the yield of crop, with the Bureau of Chemistry in studying the available plant food in soils, and with the Bureau of Soils in a soil survey. There is also a great deal of cooperative work with farmers in different parts of the State. This work involves in several instances the renting and maintenance of demonstration fields.

During the year the general assembly of the State amended the organic law of the station so as to provide for a board of control of five members appointed by the governor of the State for a term of five years each. The act defines the respective provinces of the board of control on the one hand and of the director of the station on the other, giving to the latter the entire management of the station, including all appointments, subject to such general rules as the board may prescribe, and to the approval of appointments by the board. Under this law the governor appointed a board of five practical farmers who reorganized the station with but one change in its technical staff, the entomologist being replaced by P. J. Parrott, of the New York State Station. The assembly also made appropriations for the station aggregating over $50,000, including the following items: Expenses of board of control, $1,108; bulletin illustration, $800; special work in entomology, botany, horticulture, and chemistry, $14,000; substations for field experiments, $10,000; general construction, repairs, labor, etc., $14,000; investigation of tuberculosis, $3,359; animal industry, $3,000; and library, $750. The appropriation for substations contemplates the establishment of two additional substations, one to be located in the southwestern part of the State, and to be devoted partly to the study of tobacco culture, and the other to be in the hill country of southeastern Ohio. The appropriations for general construction, etc., cover estimates for the purchase of a printing outfit in order that the station may hereafter print its own bulletins and thus avoid the delays that have heretofore occurred under the State contract system. The agriculturist of the station, J. F. Hickman, died October 22, 1902, and has been succeeded by C. G. Williams, of Gustavus, Ohio.

The past year has been one of reorganization for the Ohio Station in accordance with a legislative enactment. The same general assembly that provided for this reorganization expressed its confidence in the station by giving it the largest appropriations for research work it has ever received from the State. By this legislation the station is freed from inspection and police work of every description, and its province as an institution for research is more clearly defined than formerly. The station is now in position to develop useful lines of investigation with a better assurance than ever before that they will be carried through.

LINES OF WORK.

The principal lines of work conducted at the Ohio Station during the past year were as follows: Soils; field experiments—fertilizer and rotation experiments with corn, oats, wheat, and potatoes, variety tests of cereals; horticulture—cauliflower and other vegetables under cheese cloth, study of 175 varieties of plums, forcing tomatoes, lettuce, cucumbers, and muskmelons, variety tests of vegetables and fruits, orchard management; plant breeding—corn and wheat; diseases of plants—Rhizoctonia in potatoes, onion smut, grape rot, disease of ginseng; breeding and feeding experiments with cattle; diseases of animals—bovine tuberculosis, stomach worms of sheep; and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	21,900.00
Fees	324.80
Farm products, including balance from previous year	9,632.59
Miscellaneous, including balance from previous year	12,591.31
Total	59,448.70

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 127–132. The investigations reported in these bulletins are sugar-beet investigations in 1901, the prevention of onion smut, spraying for grape rot, and the relation of grape spraying to public health. Bulletin 129 contains a general index to reports and bulletins from Volumes I–XX, 1882–1901.

OKLAHOMA.

Oklahoma Agricultural Experiment Station, *Stillwater.*

Department of Oklahoma Agricultural and Mechanical College.

GOVERNING BOARD.

Board of Regents: F. J. Wikoff (*President*), *Stillwater;* Gov. T. B. Ferguson, *Guthrie;* H. G. Beard, *Shawnee;* T. J. Hartman (*Treasurer*), *Deer Creek;* H. C. R. Brodboll, *Ponca City;* W. H. Merten, *Guthrie.*

STATION STAFF.

John Fields, B. S., *Director; Chemist.*
L. L. Lewis, M. S., D. V. M., *Veterinarian.*
F. C. Burtis, M. S., *Agriculturist.*
Oscar M. Morris, B. S., *Horticulturist.*
W. R. Shaw, Ph. D., *Botanist, Entomologist.*
A. G. Ford, B. S., *Associate Chemist.*
L. A. Moorhouse, B. S. A., *Assistant in Soils and Crops.*
C. O. Pearcy, *Clerk and Stenographer.*

GENERAL OUTLOOK.

With few exceptions the lines of work already established were continued at the Oklahoma Station during the past year. Results were published on the feeding of cotton-seed meal, combined with other grains to hogs, also on experiments in growing potatoes. The forest-tree plantations are giving good results and are arousing considerable interest. A severe drought during the summer of 1901 afforded a good opportunity for severely testing a number of drought-resistant crops. Essex rape proved to be one of the best forage crops for this purpose, Bermuda grass one of the best pasture grasses, and alfalfa the best hay crop. Cowpeas, sorghum, peanuts, field peas, oats, wheat, rye, and rape have been grown for hog pasture. The veterinarian of the station has given considerable attention to an investigation of loco plants and the loco disease and will continue this work.

The station and college equipment have been materially increased by the erection of an addition to the library building (Pl. IV, fig. 1), costing over $17,000, and providing an auditorium and quarters for the departments of domestic economy and botany and entomology; an engineering building, costing nearly $11,000, and a two-story brick barn (Pl. IV, fig. 2), costing $6,500. The erection of these buildings and the inclosing of the college farm with a substantial wire fence have greatly improved the station facilities for work. Through the means of press bulletins, special correspondents, and farmers' organizations the Oklahoma Station has developed excellent communication with its constituents. The cooperative work which is now being started and the farmers' institute work are carried on through the officers of chartered county farmers' institutes. The station also has regular correspondents in every section of the Territory, who send in reports regarding crop conditions and other matters of mutual

FIG. 1.—OKLAHOMA COLLEGE AND STATION—LIBRARY HALL.

FIG. 2.—OKLAHOMA COLLEGE AND STATION—BARN.

interest. Quite recently these correspondents have been looking up and reporting on the alfalfa situation. These congenial relations with the people of the Territory, the evident disposition on the part of the people to give liberal support to the college and station, and the existence of a well-organized and energetic staff, put the Oklahoma Station in a position to be of great and rapidly increasing usefulness to the farming interests of the Territory.

The distribution of blackleg vaccine by the station has demonstrated the importance of vaccination as a preventive for this disease. Now that this matter has passed beyond the experimental stage, the Hatch fund should no longer be used for this purpose. If it is deemed desirable to continue this distribution at public expense the Territory should make provision for it. With the growth of the station's business there is need of additional funds to supplement the national grants, and it is hoped that these may be obtained at an early day.

LINES OF WORK.

The principal lines of work conducted at the Oklahoma Station during the past year were as follows: Chemistry; field experiments—cereals, pasture and forage crops, continuous cropping, rotation experiments, potatoes; horticulture; forestry; diseases of plants; botany; improvement of the castor bean and cotton; animal husbandry; feeding experiments; diseases of animals—blackleg, parasites, dips, loco diseases; and entomology.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	3,338.93
Total	18,338.93

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 51 and 52; Circular of Information 3; Directions for Collecting and Preserving Insects and Plants, and the Annual Report for 1901. The investigations regarding which results are published in the bulletins and annual report include the following: Wheat pasture; variety tests of fruits; notes on plant diseases and troublesome insects; beef making with corn, Kafir corn, and alfalfa; feeding cottonseed meal to hogs; cowpea hay for swine; symtomatic anthrax or blackleg; the potato crop, and variety tests of cabbage.

OREGON.

Oregon Experiment Station, *Corvallis.*

Department of Oregon State Agricultural College.

GOVERNING BOARD.

Board of Regents: J. K. Weatherford (*President*), *Albany;* J. T. Apperson, *Parkplace;* John D. Daly (*Secretary*), *Corvallis;* B. F. Irvine (*Treasurer*), *Corvallis;* W. E. Yates, *Corvallis;* Gov. T. T. Geer, *Salem;* F. I. Dunbar (*Secretary of State*), *Salem;* J. H. Ackerman (*State Superintendent of Public Instruction*), *Salem;* W. P. Keady, *Portland;* Benton Killin, *Portland;* J. M. Church, *Lagrande;* John D. Olwell, *Centralpoint;* B. G. Leedy, *Tigardville.*

STATION STAFF.

James Withycombe, M. Agr., *Director; Agriculturist.*
George Coote, *Floriculturist, Gardener.*
A. B. Cordley, M. S., *Entomologist.*
E. R. Lake, M. S., *Horticulturist, Botanist.*
A. L. Knisely, M. S., *Chemist.*
Frank E. Edwards, B. M. E., *Assistant Chemist.*
C. M. McKellips, M. S., Ph. C., *Assistant Chemist.*
F. L. Kent, B. S. Agr., *Assistant Agriculturist, Dairyman.*
E. F. Pernot, *Bacteriologist.*
Helen L. Holgate, *Stenographer.*
T. H. Crawford, M. A., *Clerk, Purchasing Agent.*

GENERAL OUTLOOK.

At the Oregon Station many of the old lines of work have been continued as heretofore, and at the same time there have been some notable developments of new investigations, as, for instance, prune drying, the utilization of the by-products of fruit in making vinegar, the preservation of silage by steaming, and the transmission of disease germs through dairy cows. The prune industry is an important one in Oregon, and the investigations concerning it have included not only those in prune drying, for which the station now has an excellent equipment, but also tests of fertilizers and cover crops for prune orchards, and the causes and prevention of prune leaf curl. The preliminary trials in preserving silage by steaming have been very successful, and the "Oregon method" gives promise of being a valuable means of making sweet silage. Considerable work has been done with early maturing varieties of corn to determine whether this cereal can be profitably grown in Oregon. Observations have been made on the use of fly repellents on a portion of the dairy herd to determine their influence on the yield of milk and gain in live weight. There have been additions to the dairy and Shorthorn herds of the college, and a number of silos have been constructed for experimental work in preserving silage by steaming. The station has continued to cooperate with the Bureau of Plant Industry of this Department in studying the influence of the origin of red-clover seed on the yield of crop, and in testing sand-binding grasses, and has undertaken cooperative work with the Bureau of

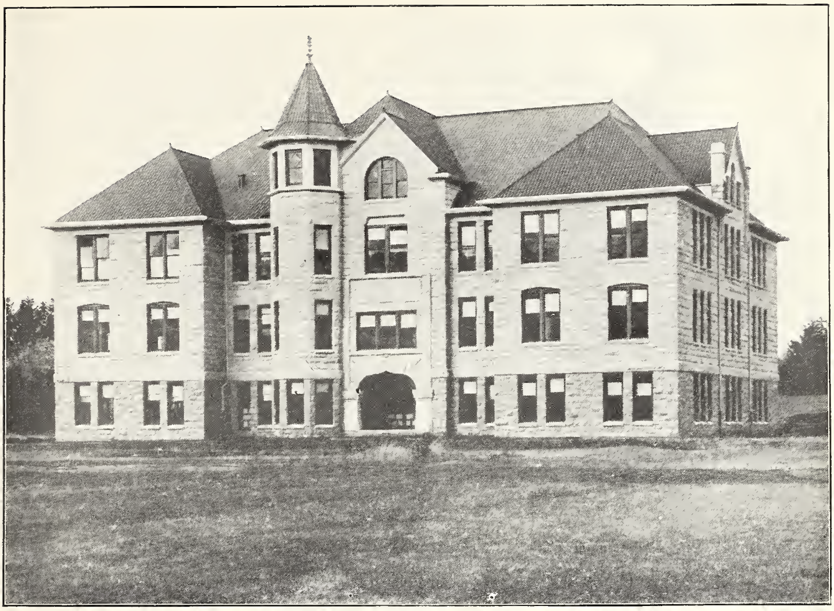

FIG. 1.—OREGON COLLEGE AND STATION—AGRICULTURAL HALL.

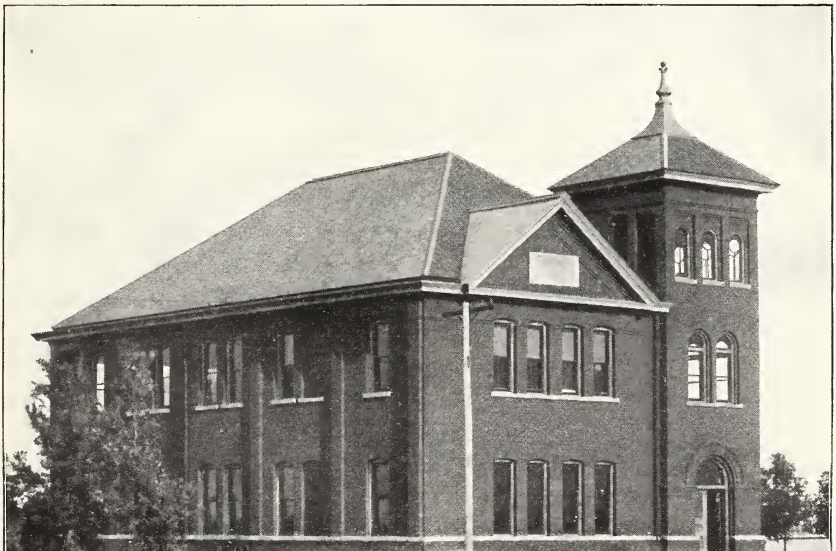

FIG. 2.—SOUTH DAKOTA COLLEGE AND STATION—PLANT BREEDING BUILDING.

Chemistry to determine the available plant food in soils. Many cooperative experiments with farmers have been conducted, including experiments in the growing of forage plants and tests of the efficiency of different spraying mixtures for controlling insect and fungus pests.

The station receives no direct appropriation from the State, but the completion of Agricultural Hall, wherein all of the station workers will be given quarters, will materially strengthen and expedite its work. This building is three stories high and is constructed of granite and sandstone. (Pl. V, fig. 1.) On the first floor is a stock-judging room and quarters for the dairy department. On the second floor is a general lecture room, a fireproof vault for records, the director's office, and rooms for the departments of agriculture and bacteriology. The departments of horticulture, entomology, and botany are located on the third floor, and the attic will be devoted to an agricultural museum.

A State appropriation of $5,000 a year is available for conducting the State station at Union in eastern Oregon, which is managed by a committee of the board of regents of the agricultural college as an enterprise distinct and separate from the station at Corvallis. The work of last year at this place was destroyed by a flood and a considerable outlay for drainage has been necessary. It is not thought that all of the 640 acres in the farm will be needed at present, so 200 acres have been leased, thus providing a considerable revenue without interfering with the experimental work. The work there has thus far been confined mainly to tests of grasses and sugar beets.

While the work of the station has been directed largely to the solution of problems of immediate pecuniary interest to the farmers of the State, it has been supported by a very substantial and creditable amount of sound scientific investigation. The extent and diversity of the agricultural interests of the State are so great that the station can not cover them all with the means now at its command. Considerable attention has been given to farmers' institutes, but there should be more ample provision for this work. There are a number of problems concerning the dairy interests, the fruit-growing industry, and the growing of hops which should be investigated. If all these varied agricultural interests are to receive the attention they deserve the State should materially increase the funds for experimental work.

LINES OF WORK.

The principal lines of work conducted at the Oregon Station during the past year were as follows: Chemistry—analytical work, investigations with silage, fertilizers for prune trees, loss of plant food from leaching; experiments in drying hops and evaporating prunes and apples; soils; field crops—rotations, variety tests of cereals, grasses, and other forage crops, fertilizer tests; horticulture; diseases of plants;

digestion and feeding experiments with dairy cows and swine, including soiling experiments with both; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, including balance from previous year	1,973.73
Total	16,973.73

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 66–69 and the Annual Report for 1901. The subjects upon which bulletins have been published are the grape in Oregon, the silo and silage, an annotated list of the birds of Oregon, the codling moth, and late spraying in Oregon. The Annual Report includes articles on sheep-feeding experiments, pig-feeding experiments, and studies of animal parasites and the lupine plant, and accounts of the work of the floriculturist and gardener, and of the horticulturist.

PENNSYLVANIA.

The Pennsylvania State College Agricultural Experiment Station,
State College.

Department of the Pennsylvania State College.

GOVERNING BOARD.

STATION STAFF.

H. P. Armsby, Ph. D., *Director.*
William Frear, Ph. D., *Vice-Director; Chemist.*
William A. Buckhout, M. S., *Botanist.*
George C. Butz, M. S., *Horticulturist.*
George C. Watson, M. S., *Agriculturist.*
Wm. C. Patterson, *Farm Superintendent.*
Julia C. Gray, *Secretary.*
J. A. Fries, B. S., *First Assistant Chemist.*
Leonard R. Cook, B. S., *Assistant Chemist.*
Thorne M. Carpenter, B. S., *Assistant Chemist.*
M. H. Pingree, B. S., *Assistant Chemist.*
H. L. Wilson, B. S., *Assistant Chemist.*
J. Plummer Pillsbury, *Assistant in Horticulture.*
A. K. Risser, *Assistant in Agriculture.*

GENERAL OUTLOOK.

The Pennsylvania Station has continued its work along a few well-defined lines and has inaugurated some new investigations. In the

agricultural department an experiment with legumes to secure a rotation suitable for soiling purposes has been started. The chemist has experimented with Sumatra tobacco under shade; the director has conducted some interesting preliminary tests and experiments with the respiration calorimeter which promises to be of great value in solving problems in the nutrition of farm animals; and the dairy husbandman has conducted and published results on an experiment to test the value of home-mixed calf meal as a substitute for milk in rearing calves. This last experiment has given exceedingly interesting and satisfactory results, and while a single season's work is not conclusive, it indicates that a very satisfactory and comparatively inexpensive substitute for milk has been devised. A number of other feeding experiments have given interesting and valuable results. The investigations in animal nutrition, in cooperation with the Bureau of Animal Industry of this Department, and the tobacco investigations in cooperation with the Bureau of Soils have been conducted as heretofore. During the present season some work in growing Sumatra tobacco under shade has been undertaken with a special State appropriation of $2,000. The chemical department of the station has tested cows in cooperation with breeders' associations.

The correspondence courses conducted by the college and station officers now enroll some 1,500 students and require the almost constant attention of one officer. Farmers' institute work also makes heavy drafts on the time of the station officers as does also control work with fertilizers, foods, and feeding stuffs. During the year the college has received the following gifts: From Andrew Carnegie, $100,000 for a library building; from Mr. and Mrs. Charles M. Schwab, $140,000 for an assembly hall, and from James Gilbert White, class of 1882, $10,000 for a graduate fellowship and $10,000 for three undergraduate scholarships. The assembly hall is now in process of construction. The director of the station has been relieved of duty as dean of the college of agriculture in order that he may devote his time more exclusively to station work, but he will continue to give a small amount of advanced instruction in the college. The dairy husbandman resigned recently to accept a similar position in New Hampshire, and the station has suffered other severe losses during the year in the resignation of a number of assistants to accept more lucrative positions.

The Pennsylvania Station is doing valuable research work along the few lines in which it has been able to develop its investigations. This is especially true in its feeding experiments, its work with the respiration calorimeter, and its long-continued rotation experiments. The farmers' institute work has been a heavy burden upon the station officers, but it has undoubtedly been of great value and has brought the college and station into closer touch with the farmers of the State in a

way that is yielding beneficial results. The station is greatly in need of additional funds not only to develop new lines of work, but also to provide suitable buildings, apparatus, and assistance for the work already in hand. The agricultural interests of the State are large and those in animal husbandry and dairying are coming especially into prominence. It is hoped, therefore, that the State will soon provide adequate funds for conducting the work of its experiment station on a scale commensurate with the importance of the agricultural interests of the State.

LINES OF WORK.

The principal lines of work conducted at the Pennsylvania Station during the past year were as follows: Chemistry—cooperation with other departments in the study of foods, feeding stuffs, excreta, fertilizers, and agricultural products, miscellaneous analytical work, study of chemical changes in vinegar and vinegar solids, and of variations in the composition of milk, experiments with tobacco, referee work for the Association of Official Agricultural Chemists of the United States; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture—variety tests of small fruits, experiments with crown gall of fruit trees, growing ginseng; field experiments—rotation experiments with fertilizers on 144 plats, rotations of legumes for soiling purposes, variety tests of farm crops; feeding experiments—investigations in animal nutrition in the respiration calorimeter, feeding steers and correlated chemical studies on the relative losses from the manure of fattening cattle under different conditions of feeding; dairying—building up herd from common stock, feeding dairy cows, study of the effect of keeping drinking water constantly before cows, effect of variety in the grain ration of cows, experiments to test the value of a home-mixed calf meal as a substitute for milk in rearing calves.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	10,201.00
Farm products	3,324.61
Miscellaneous	663.89
Total	29,189.50

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 55–59, and the Annual Report for 1900. The subjects

of the bulletins are variety tests of wheat; methods of dairy feeding; methods of steer feeding; weeds in general, two newcomers into Pennsylvania; and Pennsylvania sugar beets in 1901. A number of press bulletins were also issued.

PORTO RICO.

Porto Rico Agricultural Experiment Station, *Mayaguez.*

Under the supervision of A. C. True, Director Office of Experiment Stations, United States Department of Agriculture.

STATION STAFF.

F. D. Gardner, *Special Agent in Charge.*
O. W. Barrett, *Entomologist, Botanist.*
J. W. Van Leenhoff, *Coffee Expert.*
Paul A. English, *Assistant Agriculturist.*
C. R. Newton, *Clerk, Stenographer.*

GENERAL OUTLOOK.

The Porto Rico Station conducted during the past year experiments of a temporary nature on rented land at Rio Piedras, the results of which showed that the soil in that vicinity is in an impoverished condition and in need of fertilizers, that many northern-grown vegetables are not adapted to tropical conditions, and that there is urgent need of devising methods for combating insect pests and plant diseases. Among field crops, corn and Kafir corn were about the only ones to succeed, but among garden vegetables fairly good success was had with more than a dozen sorts, including radishes, lettuce, beets, turnips, onions, carrots, parsley, watermelons, squashes, peas, beans, and spinach. One of the worst insects on the island is the mole cricket, known as the changa, and this has been made the subject of special study, resulting in the preparation of a bulletin on its life history and habits, which has been published in both English and Spanish. In the interior the investigations with coffee were continued, principally along the lines of selection and the improvement of an old plantation by various treatments. A nursery containing many thousand coffee plants has been started. A soil survey has been conducted in cooperation with the Bureau of Soils of this Department, which includes an area of about 360 square miles extending directly across the island from Arecibo on the north shore to Ponce on the south shore.

Appropriations of $15,000 and $4,000 from the insular legislature and the municipality of Mayaguez, respectively, made possible the purchase of a farm of 230 acres near the city of Mayaguez at the west end of the island. Possession of the land was given in June and the work of repairing buildings and constructing fences and roads was at once undertaken. The buildings consist of a large dwelling house which will be adequate for the accommodation of the station staff, an old sugar house which has been transformed into offices and laboratory quarters, stables, and other outbuildings, including a brickkiln and

the usual sheds which will serve for implement sheds. The farm presents considerable variation in character of soil, topography, and exposure and is well suited to the use of the experiment station, which was moved from Rio Piedras to its new location in September, 1902. Now that the station has a permanent location, it is expected its work will be materially extended and conducted hereafter in a regular way along lines of immediate usefulness to the agriculture of the island.

LINES OF WORK.

The principal lines of work of the Porto Rico Station during the past year were as follows: Culture and fertilizer tests at Rio Piedras with a large number of northern-grown crops to determine their adaptation, time of planting, etc.; study of injurious insects and fungus and bacterial diseases of plants; selection of coffee; rejuvenation of an old coffee plantation; soil survey; and distribution of seeds for trial by farmers.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$12,000.00
Insular appropriation	15,000.00
Donation from the city of Mayaguez	4,000.00
Total	31,000.00

PUBLICATIONS.

The third report on the investigations in Porto Rico, giving a detailed account of operations during the year 1902, has been prepared by the special agent in charge of the Porto Rico Agricultural Experiment Station, and is given on page 331. Two bulletins, one relating to the organization and object of the station, the other to the life history of the changa (mole cricket), have been prepared for publication and have been issued in both English and Spanish.

RHODE ISLAND.

Rhode Island Agricultural Experiment Station, *Kingston.*

Department of Rhode Island College of Agriculture and Mechanic Arts.

GOVERNING BOARD.

Board of Managers: T. G. Mathewson (*President*), *East Greenwich;* Jesse V. B. Watson (*Vice-President*), *Wakefield;* C. H. Coggeshall (*Clerk*), *Bristol;* Melville Bull (*Treasurer*), *Newport;* Benjamin A. Jackson, *Providence.*

STATION STAFF.

H. J. Wheeler, Ph. D., *Director; Chemist.*
Fred W. Card, M. S., *Horticulturist.*
Cooper Curtice, D. V. S., M. D., *Biologist, Poultryman.*
Burt L. Hartwell, M. S., *1st Asst. Chemist.*
Jas. W. Kellogg, B. S., *Assistant Chemist.*
George E. Adams, B. S., *Assistant in Field Experiments.*
Alfred W. Bosworth, B. S., *Assistant Chemist.*
A. E. Stene, *Assistant Horticulturist.*
Nathaniel Helme, *Meteorologist.*
S. Aline Nye, *Stenographer.*
Mary G. Schermerhorn, *Stenographer.*

GENERAL OUTLOOK.

The Rhode Island Station continues to devote its efforts mainly to problems of intensive agriculture and the improvement of depleted and neglected soils. Much attention is given to manures, fertilizers, rotations, and the production of small fruits, vegetables, and poultry. The investigations on poultry are being confined largely to studies of the use of incubators and brooders. For this purpose a specially arranged poultry house has been constructed, in which arrangements have been made to regulate the temperature within definite limits. The results thus far indicate that by careful attention to temperature and moisture conditions the number of chicks hatched and reared from a given number of eggs can be materially increased over what is obtained in ordinary practice. Studies of the effect of soda as a partial substitute for potash in fertilizers are being continued. Among the features of horticultural work are experiments in crossing raspberries and blackberries in the hope of securing improved varieties of fruits, interpollination of raspberries and blackberries, experiments in the artificial propagation of blackberries; experiments to test the influence upon the color of flowers exerted by the application to the soil of various substances; an attempt to increase the frost-resisting power of beans; influence of stock upon scions and of scions from especially productive trees. Experiments in grass culture for the purpose of making a special study of the manurial requirements and treatment of grass lands are being conducted at the station and in cooperation with farmers in different parts of the State. These are awakening much interest, and promise to be very useful.

With appropriations from the State amounting to $2,900, the chemical building has been remodeled and an addition made to the station barn. At the close of the year the president of the college resigned and the director of the station has been made acting president.

The Rhode Island Station is developing its work along a few lines in accordance with a well-settled policy. It is strengthening its hold upon the farmers of the State and doing much to improve agricultural conditions.

LINES OF WORK.

The principal lines of work conducted at the Rhode Island Station during the past year were as follows: Chemistry—analytical work in connection with other experimental investigations; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments—fertilizers, rotations *v.* continuous cropping, variety tests, experiments with grasses, comparative tests of insecticides and fungicides; horticulture— rejuvenation of old orchards, manurial experiments with bush fruits, selection and breeding of fruits and vegetables, orchard cover crops, artificial propagation of blackberries, breeding experiments with raspberries and blackberries, study of forest conditions, combating insect pests, experiments in grafting; and poultry experiments—diseases, brooding, incubation, etc.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,052.01
Miscellaneous, including balance from previous year	278.79
Total	16,330.80

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 77–82 and the Annual Report for 1901. In addition to brief reports on different departments of the station these publications include reports on analyses of feeding stuffs and commercial fertilizers; a description of a modern dairy barn, and papers on rations for milch cows, the individuality of cows; grass experiments; pot experiments to test field observations concerning soil deficiencies; the forest, its influence and management; carnation stem rot; San José scale, apple maggot, trap nets; and narrow, medium, and wide rations for chickens.

SOUTH CAROLINA.

South Carolina Agricultural Experiment Station, *Clemson College.*

Department of Clemson Agricultural College.

GOVERNING BOARD.

Cheraw; L. A. Sease, *Lewiedale;* J. E. Wannamaker, *St. Matthews;* A. T. Smythe, *Charleston;* C. S. Garris, *Spartanburg;* J. E. Tindal, *Silver;* J. H. Hardin, *Chester.*

STATION STAFF.

P. H. Mell, M. E., Ph. D., *Director.*
J. S. Newman, *Vice-Director; Agriculturist.*
M. B. Hardin, *Chemist.*
H. Metcalf, M. A., *Botanist, Bacteriologist.*
B. F. Robertson, B. S., *Assistant Chemist.*
F. S. Shiver, Ph. G., *Assistant Chemist.*
H. Benton, M. S., *Assistant Agriculturist.*
C. C. McDonnell, B. S., *Assistant Chemist.*
R. N. Brackett, Ph. D., *Assistant Chemist.*
D. H. Henry, B. S., *Assistant Chemist.*
C. C. Newman, *Horticulturist.*
Charles E. Chambliss, M. S., *Entomologist.*
G. E. Nesom, B. S., D. V. M., *Veterinarian.*
C. O. Upton, *Dairyman, Animal Husbandman.*
J. S. Pickett, *Station Foreman.*
J. N. Hook, *Secretary.*
O. M. Watson, *in charge of Poultry Division.*

GENERAL OUTLOOK.

The South Carolina Station during the past year has brought to a close a number of investigations that have been in progress and has undertaken some new work, but in the main it has continued the lines of work previously inaugurated. Series of variety tests, cultural and fertilizer experiments with wheat and corn, have been brought to a close and the results prepared for publication. The same is true of the investigations in tea growing and in the evaporation of sweet potatoes. The latter work has been very successful. The potatoes are first boiled, then pared, sliced, and evaporated, after which they may be preserved indefinitely and shipped to any distance. The veterinarian has found an efficacious remedy for sore head (favus) in chickens. It consists in painting the affected parts with an alcoholic solution of pyoctanin blue. One application is said to be sufficient. In the experiments with poultry special attention has been given to the use of capons as brooders. The station is cooperating with the Bureau of Chemistry of this Department in studying the available plant food in soils, and with the Bureau of Forestry in growing black locust for fence posts and several species of oak. The entomologist has recently secured the cooperation of fruit growers in different parts of the State in studying and combating injurious insects.

The general assembly of the State at its last session enacted a law requiring the authorities of Clemson College to undertake experiments along the coast with sea-island cotton, rice, truck crops, and a study of diseases affecting the same. At the close of the year the president of the college and director of the station resigned to accept the presidency of the University of Arkansas, and was succeeded by P. H. Mell, formerly director of the Alabama Station. The vacancy in the department of botany and bacteriology has been filled by the election of H. Metcalf, formerly of the University of Nebraska. A new barn has been completed for the dairy division of the station. It has a capacity

for 36 cows, storage room for hay and grain, and 4 brick silos with a capacity of 50 tons each. It is hoped that this will make it possible to put the experimental work in dairying on a more efficient footing. Additions aggregating over $50,000 in cost have also been made to the buildings and equipment of Clemson College. Farmers' institutes were held in 14 different places in the State during the year, and members of the station staff assisted in the work. During the year some progress was made in the more definite separation of the general work of the college from the experimental work of the station, but further differentiation of the work and a more consistent and vigorous policy regarding the station are needed.

LINES OF WORK.

The principal lines of work conducted at the South Carolina Station during the past year were as follows: Chemistry—chemistry of sea island cotton, plant food in soils, analysis and control of fertilizers; field experiments—domestication of native grasses and other forage crops, test of crops for economic pork production, rotations, tests of sorghum and Kafir corn for hay; horticulture—selection and development of seedling apples and pecans, celery growing, spraying experiments, canning fruit and vegetables, diseases of fruits, experiments with Irish potatoes; plant breeding—cotton, strawberries; feeding experiments—mainly with dairy cows and poultry; veterinary science—diseases of poultry, inoculation for Texas fever; entomology—orchard inspection, methods of destroying the insect pests of fruits and vegetables; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,030.39
Total	16,030.39

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 64–71 and the Annual Reports for 1900 and 1901. The subjects of the bulletins are as follows: Analysis of commercial fertilizers; San José scale, with a few suggestions for its treatment, and rules and regulations adopted by State board of entomology; feeding corn stover; dehorning milch cows; stock feeding; a chemical study of

the sea-island cotton seed; brown rot of peaches and plums; analysis of commercial fertilizers; and new method of preserving sweet potatoes. The annual reports include brief reports from the different departments of the station.

SOUTH DAKOTA.

South Dakota Agricultural Experiment Station, *Brookings.*

Department of South Dakota Agricultural College.

GOVERNING BOARD.

Regents of Education: Frederick A. Spafford (*President*), *Flandreau;* I. D. Aldrich (*Secretary*), *Bigstone;* I. W. Goodner, *Pierre;* M. F. Greeley, *Gary;* L. M. Hough, *Sturgis;* R. M. Slocum, *Herried;* R. A. Larson (*Secretary and Accountant*).

STATION STAFF.

Jas. W. Wilson, M. S. A., *Director; Animal Husbandman.*
E. C. Chilcott, M. S., *Vice-Director; Agriculturist.*
Jas. H. Shepard, B. S., *Chemist.*
De Alton Saunders, M. A., *Botanist.*
E. L. Moore, B. S., D. V. S., *Animal Pathologist.*
N. E. Hansen, M. S., *Horticulturist.*
W. S. Thornber, *Assistant Horticulturist.*
A. B. Holm, B. S., *Assistant in Soils.*
A. H. Wheaton, *Assistant in Dairying.*
Frank Hepner, B. S., *Assistant in Chemistry.*
R. F. Kerr, *Librarian, Statistician.*
R. A. Larson, *Accountant and Secretary.*

GENERAL OUTLOOK.

The lines of work at the South Dakota Station during the past year have been mostly a continuation of investigations previously inaugurated. The objects of much of the work, both in agricultural and horticultural lines, are the introduction and development of hardy and drought-resistant varieties of plants adapted to local conditions. In the agricultural department special attention has been given to the improvement of cereals by breeding and selection in cooperation with the Bureau of Plant Industry of this Department and with other Northwestern stations, tests of promising introductions, rotations adapted to South Dakota conditions, and studies of soil moisture in relation to culture and cropping. The botanist is very effectively cooperating with the agriculturist in the plant-breeding work, the latter growing on a larger scale the promising varieties produced in small quantities by the former. Provision has been made by the purchase of a small flour mill to study the milling properties of the varieties of grain produced. In the horticultural work special attention is being given to improving native fruits and to the introduction and improvement by crossing and selection of hardy fruits, especially apples. The limitations of fruit growing in this region render this line of work especially important and necessary. The cooperative range and forage

experiments at Highmore, begun in 1899 with a State appropriation of $1,000 a year and conducted in cooperation with the Bureau of Plant Industry, have been continued with considerable success in demonstrating the value of a number of grasses and forage plants for the improvement of ranges and for growth in regions subject to severe drought. Cooperative investigations are in progress with the Bureau of Chemistry on the available plant food in soils and with this Office in irrigation.

The station equipment has been considerably improved by the completion of a building for plant breeding with attached greenhouses. (Pl. V, fig. 2.) The building is of brick, two stories high, and cost about $10,000. A rat-proof seed house, costing $650, has been erected and a herd of common dairy cows purchased for the purpose of carrying on experiments along dairy and feeding lines. The college with which the station is connected has also completed a $40,000 physics and engineering building.

The South Dakota Station is again under the administration of an executive officer other than the president of the college. It is the plan of the director to give animal husbandry and dairying an important place in the investigations of the station, and the recent special appropriation of the State legislature for restocking the college farm will enable him to successfully inaugurate the work. The farmers of the State appreciate the value of the work carried on for the introduction and development of varieties of fruits and forage plants suited to the climate of the State, and there is good reason to believe that under the administration of a competent executive officer, who is also interested in developing the work in animal husbandry, the work of the station will come to be much better appreciated.

LINES OF WORK.

The principal lines of work conducted at the South Dakota Station during the past year were as follows: Physics and chemistry of soils; field experiments—rotations; plant breeding—selection and adaptation, including native and introduced fruits, cereals, and forage crops; diseases of plants and animals; animal husbandry; dairying; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,000.00
Farm products	437.01
Miscellaneous	213.58
Total	16,650.59

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 70–74 and the Annual Report for 1901. These bulletins include two reports on the investigations with drought-resistant forage crops at Highmore, a comparison of spelt and barley for feeding, a report of investigation of variations in cream and milk tests, and a bulletin on ornamentals for South Dakota.

TENNESSEE.

Tennessee Agricultural Experiment Station, *Knoxville.*

Department of the University of Tennessee.

GOVERNING BOARD.

STATION STAFF.

Andrew M. Soule, B. S. A., *Director; Agriculturist.*
Chas. A. Keffer, B. H., *Horticulturist, Forester.*
C. A. Mooers, B. S., *Chemist.*
S. M. Bain, B. A., *Botanist.*
Weston M. Fulton, B. A., M. S., *Meteorologist.*
F. H. Broome, *Librarian.*
John R. Fain, B. S., *Farm Manager.*
Phares O. Vanatter, *Plat Expert.*
Samuel E. Barnes, B. S., M. S. A., *Dairyman.*
Moses Jacob, V. M. D., *Veterinarian.*
Ethel Reese, *Stenographer.*

GENERAL OUTLOOK.

The Tennessee Station is directing its efforts mainly to problems concerned with the introduction of diversified farming. Important among the lines of work undertaken in this connection are those in animal production, the improvement of soils, and the introduction of fruit growing. Closely correlated with this work is the effort to introduce winter cereals and legumes for feeding and for soil improvement and the experiments in establishing meadows and pastures, all of which have been very successful. The value of legumes as soil renovators has been fully demonstrated on the station farm. The experiment with soiling and silage crops (Pl. VI, fig 1) has been highly successful, some of the crops yielding as high as 20 tons per acre, while silage was made at a cost of $1.23 per ton. The experiments with cereals, grasses, forage plants, and clover seed are conducted in cooperation with the Bureau of Plant Industry of this Department, and there are

also feeding experiments in cooperation with the Bureau of Animal Industry. The botanist has completed important investigations on the effects of copper salts on the foliage of peach trees, and has published a detailed report on the subject.

A new hog barn was erected during the past year. It is 18 by 100 feet, and contains a feed room 18 feet square in one end and 16 pens, each 7 by 10 feet. Half of the building is intended for the use of brood sows and the other half for feeding pens for experimental purposes. Experiments in grazing hogs on cowpeas and other crops have been undertaken. (Pl. VI, fig. 2.)

The work of the station continues to find favor with the farmers of the State, who are reached in different ways—through farmers' institutes organized by the station and by the commissioner of agriculture and attended by members of the station staff, by regular bulletins and press bulletins, and by an annual yearbook on agricultural subjects, which is issued in an edition of 35,000 copies and is paid for by advertisements. The farmers' conference held at the college each spring continues to be well attended and is an important agency in bringing the work of the station before the people. The university with which the station is connected is making vigorous efforts to arouse an interest in agricultural education and to improve the condition of the rural schools in the State. A summer school for teachers, held during the past summer, had an enrollment of over 2,000. The great need of both the university and the station is financial aid from the State. Both are doing good work and are in position to greatly extend their influence in case such aid is secured.

LINES OF WORK.

The principal lines of work conducted at the Tennessee Station during the past year were as follows: Chemistry—pot and other experiments with soils, analytical work; fertilizers; field experiments—selection of cereals and legumes, experiments with forage crops for soiling and silage, methods of cultivation, green manuring, tests of meadow grasses, grazing experiments, etc.; horticulture—culture, fertilizer, and grafting experiments with orchard and small fruits; seeds; weeds; diseases of plants; feeding experiments—beef and dairy cattle and hogs; entomology; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products, dairy and live stock	3,809.20
Total	18,809.20

FIG. 1.—TENNESSEE STATION—COWPEAS AND SORGHUM FOR SILAGE.

FIG. 2.—TENNESSEE STATION—GRAZING HOGS ON COWPEAS.

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins Vol. XIV, Nos. 2–4, and Vol. XV, Nos. 1 and 2, and the Annual Report for 1901. The subjects of the bulletins received are winter wheat; winter cereals and legumes; the early growth and training of apple trees; the value of corn, skim milk, and whey for fattening swine, and the action of copper on leaves. The Annual Report contains brief reports from the different departments of the station. The station has also published numerous press bulletins and a yearbook which has been issued without expense to the station.

TEXAS.

Texas Agricultural Experiment Station, *College Station.*

Department of the State Agricultural and Mechanical College of Texas.

GOVERNING BOARD.

Board of Directors: M. Sansom (*President*), *Alvarado;* F. A. Reichardt, *Houston;* A. C. Oliver, *Douglassville;* William Malone, *Hunter;* P. H. Tobin, *Denison;* A. P. Smyth, *Mart;* John W. Kokernot, *San Antonio;* Jeff Johnson, *Austin.*

STATION STAFF.

William D. Gibbs, M. S., *Director.*
H. H. Harrington, M. S., *Chemist.*
M. Francis, D. V. M., *Veterinarian.*
B. C. Pittuck, B. S. A., *Agriculturist.*
E. J. Kyle, M. S. *Horticulturist.*
E. Dwight Sanderson, B. S. A., *Consulting Entomologist.*
E. C. Green, B. S., *Assistant Horticulturist.*
N. Fraenkle, Ph. D., *Assistant Chemist.*
J. W. Carson, B. S. A., *Farm Superintendent.*
J. G. Harrison, *Bookkeeper.*
J. J. Hooper, B. S. A., *Stenographer, Clerk.*
B. B. Hemphill, *Mailing Clerk, Librarian.*
S. A. McHenry, *Superintendent State Station (Beeville).*
E. P. Stiles, *Superintendent State Station (Troupe).*

GENERAL OUTLOOK.

The work of the Texas Station has been continued as heretofore. Results of investigations with forage crops, onions, figs, tobacco soils, Texas fever, and insect pests of truck crops have been published, and material is now in hand for reports on watermelons grown at the Beeville substation, and on cane sirup. The cooperative work of the station has been doubled and now includes experiments with corn, cotton, forage plants, and fertilizers for truck crops with about 200 farmers. Cooperation with this Department includes experiments with grasses and forage crops for pastures and meadows and cereal investigations

with the Bureau of Plant Industry, irrigation investigations with this Office, and soil investigations with the Bureau of Soils. Work at the Beeville substation on the 80 acres under cultivation is largely with truck crops and a few fruits, with supplementary work in irrigation and with fertilizers. This substation had an appropriation for additions to buildings and has been conducted in such a way as to meet the cordial approval of the people in the section where it is located. The new substation for which the legislature made an appropriation has been located in the fruit-growing region of eastern Texas at Troupe, on 150 acres of donated land, a part of which is cleared. The work of this substation will be along the lines of truck and general farming and fruit growing.

The new building for the departments of chemistry and veterinary science, for which the legislature appropriated $31,000, is nearing completion. Several changes have been made in the college and station staff. David F. Houston, formerly of the University of Texas, has been elected president of the college. At the close of the year the director resigned to go into editorial work and has been succeeded by W. D. Gibbs, formerly of the New Hampshire College and Station, who has also been made dean of agriculture in the college. The horticulturist resigned and was succeeded by E. J. Kyle. There was also a change in the position of assistant horticulturist, and the position of consulting entomologist was established, to which E. Dwight Sanderson, of Delaware, was appointed.

In its investigations and in bringing the results of its work before the people, the Texas Station has made notable progress. A number of important investigations have been made, notable among which are those with Texas fever, and new industries of great importance to certain sections of the State have been introduced largely through the influence of the station. The annual sessions at the college of the Texas Farmers' Congress, the cooperative work with farmers, and the operations of the substations have all contributed to a better understanding among the farmers of the importance of the station work, and it is encouraging to note a growing tendency to make liberal State appropriations for the support of these various lines of investigation. The numerous recent changes in the personnel of the station are unfortunate, being largely the results of the lack of a firm and consistent policy of general management. If this is remedied under the new administration and the affairs of the station are put on a sound and permanent basis, the Texas Station may easily be brought into a state of great efficiency and usefulness.

LINES OF WORK.

The principal lines of work conducted at the Texas Station during the past year were as follows: Chemistry; meteorology; soils; field experiments—forage crops, variety tests, fertilizer experiments with

corn and cotton; horticulture—variety and fertilizer experiments with tomatoes and experiments with berries and figs; feeding experiments; diseases of animals; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	15,000.00
Miscellaneous, including balance from previous year	659.22
Total	30,659.22

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 59–64, and the Annual Reports for 1900 and 1901. The bulletins include reports of investigations on forage crops, two methods of growing onions, tobacco soils, the fig, Texas fever, and insect pests attacking truck crops. Eleven varieties of figs are reported as successful on the station grounds.

UTAH.

Agricultural Experiment Station, *Logan.*

Department of the Agricultural College of Utah.

GOVERNING BOARD.

STATION STAFF.

John A. Widtsoe, Ph. D., *Director, Chemist.*
James Dryden, *Meteorologist, Poultry Manager.*
Geo. L. Swendsen, C. E., *Hydraulic Engineer.*
Lewis A. Merrill, B. S., *Agronomist.*
E. D. Ball, M. S., *Biologist.*
John A. Crockett, *Assistant Dairyman.*
P. A. Yoder, Ph. D., *Associate Chemist.*
W. W. McLaughlin, *Assistant Chemist.*
Wm. N. Hutt, B. S. A., *Horticulturist.*
Allan M. Fleming, *Treasurer.*
Peter W. Maughan, *Secretary.*
Charles Batt, *Foreman Horticultural Grounds.*
J. B. Nelson, *Farm Foreman.*
William D. Beers, *Assistant Irrigation Engineer.*
Robert Stewart, *Assistant Chemist.*

GENERAL OUTLOOK.

The Utah Station is developing its work around irrigation as the most important feature, and the different departments are cooperat-

ing in this scheme of conducting investigations. For example, the chemist is analyzing soils, the water used in irrigation, and the crops grown under irrigation, and is devising a new form of centrifugal apparatus for the mechanical analysis of soils; the irrigation engineer is measuring water on the station plats and on the new station farm, where an extensive system of wooden flumes with triangular laterals is being installed for measuring the water required by different crops (Pl. VII, fig. 1); the agronomist is conducting variety tests and cultural experiments with grains, grasses, forage plants, and other crops grown under irrigation, and the department of animal husbandry will conduct feeding experiments to determine the nutritive value of plants grown under irrigation. Seepage, drainage, and alkali investigations are conducted in cooperation with the Bureau of Soils of this Department on a 40-acre tract of land near Salt Lake City; experiments with grasses and forage plants for arid and alkali soils in cooperation with the Bureau of Plant Industry, and studies of available plant food in soils and sugar-beet investigations with the Bureau of Chemistry. The station is also conducting some investigations in dry farming for the benefit of areas where irrigation is not practicable. Farmers' institutes are conducted by the college and station with a State fund of $1,500.

The new barns for cattle and sheep, provided for by the last legislature, have been completed at a cost of about $12,000 (Pl. VII, fig. 2), and a vegetation house at a cost of $1,500. The college has purchased a considerable number of improved live stock, which will be available for station use. At the close of the fiscal year the horticulturist resigned and has since been succeeded by W. N. Hutt, of the department of agriculture, Guelph, Ontario. Since the close of the year the animal husbandman also has resigned to accept a similar position in Montana.

In Utah, where irrigation is so universal and essential, the concentration of efforts on a few problems related to farming under irrigation seems to be a wise policy, and good progress is being made under the vigorous prosecution of this scheme. At the same time the station is not neglecting investigations in dry farming. A special bulletin on this subject has been issued, and there are in the vicinity of the station many evidences of a great increase of farming by this method on the uplands where irrigation is impracticable. Frequent changes in the division of horticulture have rendered this part of the station's work relatively ineffective. It is hoped that this may hereafter be remedied, as the horticultural interests of the State are of great importance. The farmers' institute work needs to be developed in the direction of giving the farmers a larger amount of definite instruction relating to the actual problems of their business.

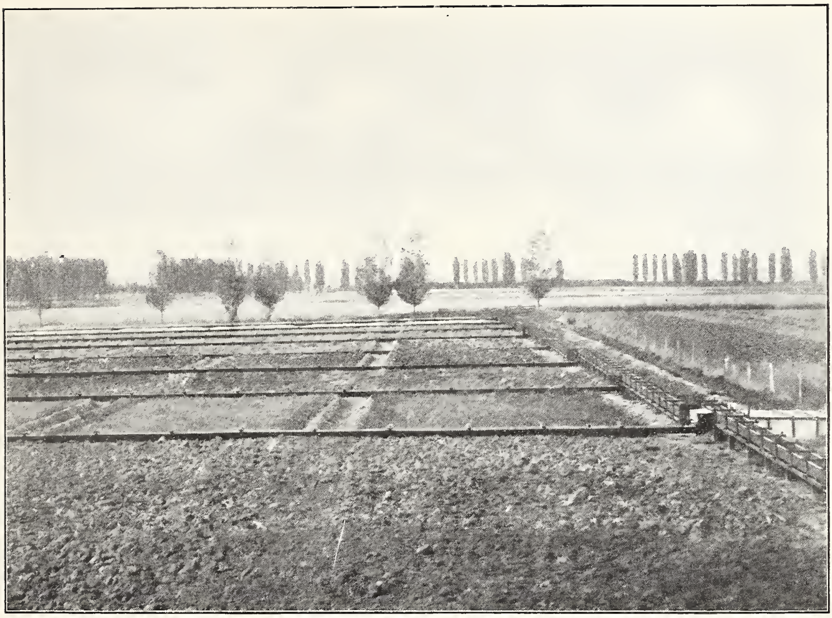

FIG. 1.—UTAH STATION—PLATS AND FLUMES FOR IRRIGATION.

FIG. 2.—UTAH STATION—CATTLE AND SHEEP BARNS.

LINES OF WORK.

The principal lines of work conducted at the Utah Station during the past year were as follows: Chemistry—soils, feeding stuffs; alkali soil investigations—reclamation of alkali soils; meteorology; field experiments—rotations, testing varieties of cereals, sugar beets, and garden vegetables, arid farming; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments—sheep, horses; dairying; poultry experiments; irrigation—seepage investigations, water requirements of plants and soils; and arid farming.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,819.67
Balance from previous year, and miscellaneous	712.01
Total	17,531.68

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 72–76, including reports on a soil survey in Salt Lake Valley, experiments in butter making and cheese making, lead ore in sugar-beet pulp, arid farming or farming without irrigation, forcing lettuce. A number of cattle died after being fed sugar-beet pulp, and an investigation showed that the cause of death was poisoning from lead ore which had been shipped in the cars before the pulp was shipped in them, and fragments of which were found in the stomachs of the dead cattle.

VERMONT.

Vermont Agricultural Experiment Station, *Burlington.*

GOVERNING BOARD.

Board of Trustees—Board of Control: Matthew Henry Buckham (*President*), *Burlington;* E. J. Ormsbee, *Brandon;* G. S. Fassett, *Enosburg;* Cassius Peck, *Burlington.*

STATION STAFF.

J. L. Hills, B. S., *Director.*
G. H. Perkins, Ph. D., *Entomologist.*
L. R. Jones, Ph. B., *Botanist.*
William Stuart, M. S., *Horticulturist.*
F. A. Rich, V. S., M. D., *Veterinarian.*
Cassius Peck, *Farm Superintendent.*
C. H. Jones, B. S., *Chemist.*
W. J. Morse, B. S., *Assistant Botanist.*
E. S. Gregg, *Dairyman.*
Mary A. Benson, *Stenographer.*
E. H. Powell, *Treasurer.*

GENERAL OUTLOOK.

The work of the Vermont Station during the past year has been along the same lines as those hitherto pursued. With the exception of receipts from farm products the income of the station for investigational purposes is limited to the Hatch fund, hence the necessity and wisdom of confining the investigations to a few important lines, such as dairying, animal husbandry, horticulture, and plant diseases. Cooperation with this Office in conducting nutrition investigations was continued, and arrangements have been made to cooperate with the Bureau of Plant Industry of this Department in investigating drug-producing plants and pasture and meadow grasses for wet lands, and with the Bureau of Chemistry in studying the available plant food in soils. The lower story of the building in which the station has its headquarters has been turned over to the agricultural college and experiment station, and the offices of the director have been moved to this story. This gives the station better facilities for chemical investigations on the second floor. The recent gifts to the university of the C. G. Pringle herbarium and of the botanical library and herbarium of C. C. Frost will incidentally be of much assistance to the station. Mr. Pringle has accepted an appointment as keeper of the herbarium. The Frost collection is rich in specimens of fungi, and will thus be of value in connection with the study of plant diseases. The horticulturist has resigned to accept a position at the Massachusetts Agricultural College and has been succeeded by William Stuart, formerly of the Indiana Station.

The increased calls upon the station for advice and assistance and the rapid growth of the bulletin mailing list indicate that it is year by year coming into more helpful and cordial relations with its constituents. In addition to the regular bulletins the station has distributed a few poster bulletins and biweekly newspaper bulletins which have quite generally been printed by the newspapers of the State. The fact that the State provides funds for printing and distributing the publications of the station enables the latter to devote its funds more closely to the work of investigation.

LINES OF WORK.

The principal lines of work conducted at the Vermont Station during the past year were as follows: Chemistry—composition of potatoes, artichokes, etc., methods of analysis; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; botany—grasses and other forage crops, destruction of weeds, etc.; horticulture—propagation, pollenization, and hybridization of plums; diseases of plants; feeding experiments; and dairying.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	1,000.00
Fees	3,483.53
Farm products	7,032.76
Total	26,516.29

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 87–92, and the Annual Reports for 1900 and 1901. The bulletins, with the exception of those on plum culture and apple growing, are reports of analyses of fertilizers and feeding stuffs. The annual reports contain, in addition to financial statements and brief reports by the director, a large number of articles on the different investigations that have received attention at the station. The articles in the report of 1900 were on the composition of potatoes at various stages of growth, composition of artichokes, pollination of apples, propagation of plums—preliminary report, further work in plum pollination, the myrobalan plum, impurities of grass and clover seed, killing weeds with chemicals, potato diseases and their remedies, a soft rot of carrot and other vegetables, plum-tree canker, leaf-scorching of trees by the wind, feeding trials with cows, the effect of feed on the quality of butter, record of dairy herd; those in the report for 1901, composition of nitrogen-free extract matter in potatoes and in artichokes, miscellaneous analyses, organic nitrogen availability of fertilizing materials, fowl meadow grass, an inventory of apples grown in Grand Isle County, propagation of plums—second report, hybrid plums—third report, two weedy plants new to America, the bird vetch or wild pea, killing weeds with chemicals, potato diseases and their remedies, feeding trials with cows, a comparison of feeding-trial methods, the effect of feed on the quality of butter, and testing Babcock milk and cream bottles.

VIRGINIA.

Virginia Agricultural Experiment Station, *Blacksburg.*[a]

Department of Virginia Agricultural and Mechanical College.

GOVERNING BOARD.

Board of Control: J. T. Brown, *Brierfield;* D. M. Cloyd, *Dublin;* B. R. Selden, *Richmond;* W. R. Robertson, *Plasterco;* J. M. McBryde (*President College*), *Blacksburg.*

[a] Express and freight address, *Christiansburg Depot.*

STATION STAFF.

J. M. McBryde, Ph. D., LL. D., *Director.*
W. B. Alwood, *Vice-Director; Entomologist, Mycologist.*
E. A. Smyth, jr., M. A., *Biologist.*
D. O. Nourse, B. S., *Agriculturist.*
R. J. Davidson, M. A., *Chemist.*
Meade Ferguson, Ph. D., *Assistant Agriculturist.*
H. L. Price, B. S., *Assistant Horticulturist.*
J. G. Ferneyhough, D. V. S., *Veterinarian.*
J. H. Gibboney, *Assistant Chemist.*
C. W. Harrison, *Assistant Chemist.*
C. I. Wade, *Treasurer.*

GENERAL OUTLOOK.

The Virginia Station during the past year, in addition to carrying on its former lines of important work in horticulture, the utilization of fruit products, entomology and veterinary science, has outlined considerable new field work with forage crops and fertilizers, bacteriological studies with milk and soils, and feeding experiments with beef and dairy cattle and swine. Special attention will be given to studies of ferments of cider, vinegar, and wine, the mycologist and chemist cooperating in this work. The soil survey in cooperation with the Bureau of Soils of this Department, and the investigations with sugar beets and in methods of manufacturing cider in cooperation with the Bureau of Chemistry, have been continued, and a study of the available plant food in soils in cooperation with the Bureau of Chemistry has been undertaken. Ten of the bulletins received from this station during the past year have been issued by the department of veterinary science in a series of popular articles on animal parasites and the teeth of horses and cattle.

Numerous recent improvements to the college equipment will materially improve the station facilities. A large Science Hall (Pl. VIII, fig. 1), three stories high, with attic containing photographic rooms and basement containing rooms for distillation and a dynamo laboratory, has been completed. On the third floor of this building the station chemist will have laboratories which will be especially fitted up for research work and entirely separated from the laboratories used by students. On the first floor the biologist of the station will have a separate laboratory for research work. A two-story brick building, formerly used for a residence (Pl. VIII, fig. 2), has been refitted for the department of agriculture headquarters, and several rooms in it will be devoted especially to station work. There are also four new residences for college and station officers, a new dormitory, and other improvements in the way of remodeled buildings, new walks, fences, etc. The horticultural department has been assigned 25 acres of the college farm in the rear of the present orchard, on which an orchard for fertilizer tests and other experiments on a commercial scale will be set out. The college farm, which now occupies 1,000 acres, including adjacent leased land, will henceforth be in charge of the present agriculturist, who will be relieved largely from station duties, while experimental work will be

FIG. 1.—VIRGINIA COLLEGE AND STATION—SCIENCE HALL.

FIG. 2.—VIRGINIA COLLEGE AND STATION—AGRICULTURAL HALL.

performed by the assistant agriculturist, Meade Ferguson, Ph. D., a graduate of the Virginia Polytechnic Institute, who has recently taken the doctor's degree at Leipzig, having pursued agricultural subjects at that university. The college now has a fine herd of beef and dairy cattle, besides swine and sheep. The work of the State veterinarian has been separated from that of the station, and the experimental work will be carried on by the assistant veterinarian, J. G. Ferneyhough. The former assistant in this department has been promoted to the position made vacant by the resignation of E. P. Niles.

The officers of the Virginia Station are showing commendable enterprise in developing lines of work closely related to the great agricultural and horticultural industries of the State. Both the station and the college with which it is connected are more largely attracting the attention of the farmers in the State, and there is an encouraging increase in the number of students pursuing agricultural courses in the college. However. the available funds are not adequate for the support of the college under such conditions or for the development of needed new lines of investigation. The State has made quite liberal appropriations recently for improvements and current expenses at the college, and it is hoped that these will be continued and additional funds supplied for experimental work. With the carrying out of the present plans for the differentiating and strengthening of the station work it is hoped that a much larger amount of original research will be undertaken, the results of which will be of practical usefulness to farmers in Virginia and elsewhere.

LINES OF WORK.

The principal lines of work conducted at the Virginia Station during the past year were as follows: Field experiments—study of forage plants, corn and other crops, tillage and manurial experiments, analysis of foods; horticulture; bacteriology—of milk and soils, critical study of nitrifying and denitrifying bacteria; feed experiments—feeding steers, study of corn stover, wheat straw, cotton-seed hulls, etc., as substitutes for hay; veterinary science; entomology; cider and vinegar making; and study of ferments.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	20.81
Total	15,020.81

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 111-122 and the Annual Report for 1901. Bulletins 111-114 constitute parts 4 to 7 of the series on animal parasites. Bulletins 115-117 form a series on the teeth of the horse as affected by age. Bulletin 118 is on the teeth of cattle and sheep as affected by age. Bulletins 119 and 120 are on the common irregularities of the teeth of the horse, Bulletin 121 on steer feeding, and Bulletin 122 on the comparative skimming qualities of Holstein and Jersey milk.

WASHINGTON.

Washington Agricultural Experiment Station, *Pullman.*

Department of Washington Agricultural College and School of Science.

GOVERNING BOARD.

Board of Regents: F. J. Barnard, *Seattle;* R. C. McCroskey, *Garfield;* H. W. Canfield (*Vice-President*), *Colfax;* J. W. Stearns (*Treasurer*), *Tekoa;* H. D. Crow (*President*), *Spokane.*

STATION STAFF.

E. A. Bryan, M. A., *Director.*
E. E. Elliott, M. S., *Agriculturist.*
Chas. V. Piper, M. S., *Botanist, Zoologist.*
N. O. Booth, B. Agr., *Horticulturist.*
Elton Fulmer, M. A., *Chemist.*
Sofus B. Nelson, D. V. M., *Veterinarian.*
H. S. Davis, Ph. D., *Assistant Zoologist.*
R. E. Snodgrass, M. A., *Assistant Entomologist.*
George Severance, B. S., *Assistant Agriculturist.*
R. W. Thatcher, B. S., *Assistant Chemist.*
David A. Brodie, B. S., *Superintendent Puyallup Station.*
R. Kent Beattie, M. A., *Assistant Botanist.*
J. S. Cotton, B. A., *Assistant Cooperative Range Experiments.*
O. L. Waller, *Irrigation Engineer*

GENERAL OUTLOOK.

The work of the Washington Station has undergone but few changes during the past year. The lines of work previously begun have been continued, and considerable new work has been undertaken, especially in the department of veterinary science which was given a State appropriation of $1,250 for two years. The State provides no funds for the examination of fertilizers, foods, and dairy products, which is done by the station chemist. Among the features of the station work are experiments in breeding and selecting varieties of corn and winter wheat suited to the region; investigations with orchard and small fruits and their insect and fungus pests, experiments in propagating salmon on Puget Sound, and cooperative range experiments with grasses and forage crops. These last experiments are conducted in cooperation with the Bureau of Plant Industry of this Department. There is also cooperative work with the Bureau of Chemistry on the available plant food in soils, and with this Office on irrigation. The chemical labora-

tory, for which the State appropriated $25,000, is now building. When completed, the various departments of the station will have excellent equipment. During the year the horticulturist resigned and has since accepted a similar position in West Virginia University and Station. George Severance, formerly of the Michigan Agricultural College, has been appointed assistant in agronomy and soil physics.

Work at the Puyallup Substation has been continued with a State appropriation of $8,000 for two years. The present equipment of this station consists of a small farmhouse, a small office and laboratory building, a small new barn, an old barn, and 40 acres of very uneven land, including gravelly hill soil, sandy and heavy loam bottom land, and "beaver dam" (muck soil). Only a small part of the hill land is cleared. A herd of Angora goats has been purchased mainly for the purpose of clearing this land. The bottom land has been under cultivation for a number of years and is used for tests of varieties of strawberries, potatoes, and forage plants. Some attention is also given to raspberries, blackberries, orchard fruits (especially apples), and hops. The superintendent has an assistant who gives his attention mainly to work on plant diseases and insect pests, and a farm foreman is regularly employed. The conditions at this substation are so entirely different from those of the Palouse region, in which the main station is located, that it is believed that a very useful work can be done here supplementing that of the station at Pullman.

The Washington Station has a large amount of valuable work in progress, which is closely related to the agricultural needs of the State, but important changes in the station staff have been a serious hindrance to the greatest efficiency of the station. Some progress has been made during the year in differentiating station work from the other college operations on the farm, and it is expected that this will be carried still further in the future. On recommendation of the president of the college the board of control has approved the policy of separating the office of director of the station from that of president, and the holding of stated meetings of the station staff as an advisory council. In view of the growth of the work of the college and the increasing importance of the agricultural interests of the State, this action of the board is undoubtedly wise, and it is hoped that a separate station director will be appointed at an early day.

LINES OF WORK.

The principal lines of work conducted at the Washington Station during the past year were as follows: Chemistry—methods of analysis, chemical studies of potatoes and oats and of fertilizers, foods, and dairy products; botany—study of crown gall, black spot, canker, tomato blight, pear blight, grain smuts; bacteriology; soils—subsoiling and soil treatment; field experiments—tests of grasses for pasture, varieties

of oats, barley, emmer, spelt, and einkorn, rotations, time of seeding, sugar beets; horticulture—cover crops and fertilizers for orchards, spraying for apple scab, protection from frost, varieties of fruits and vegetables, selection of nursery stock; plant breeding—cereals, clover, alfalfa, and vetches; diseases of plants; feeding and breeding experiments—cattle, swine, and sheep; veterinary science—control of the squirrel pest, poisonous effect of certain plants on sheep, influence of feeding fungi to horses, glanders, tuberculosis of cattle, heaves, study of influence of animal fat as a conservor of heat; entomology—study of the codling moth in cooperation with other northwestern stations, insects affecting cereals, San José scale and remedies for the same, parasitic diseases of crickets; dairying; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	6,089.57
Miscellaneous, including fees and farm products	645.51
Total	21,735.08

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletin 47 on the variegated cutworm, Bulletin 48 on a mechanical ration computer, and Bulletin 49 on alkali and alkali soils.

WEST VIRGINIA.

West Virginia Agricultural Experiment Station, *Morgantown.*

Department of West Virginia University.

GOVERNING BOARD.

Board of Regents: E. M. Grant, *Morgantown;* C. E. Haworth, *Huntington;* J. W. Hale, *Princeton;* C. M. Babb, *Falls;* J. R. Trotter, *Buckhannon;* D. C. Gallaher, *Charleston;* J. B. Finley, *Parkersburg;* C. D. Oldham, *Moundsville;* W. J. W. Cowden, *Wheeling.*

STATION STAFF.

J. H. Stewart, M. A., *Director, Agriculturist.*
Bert H. Hite, M. S., *Vice-Director, Chemist.*
S. W. Fletcher, M. S., Ph. D., *Horticulturist.*
Gilbert M. John, *Assistant Horticulturist.*
W. M. Morgan, B. S. A., *Assistant Horticulturist.*
W. E. Rumsey, B. S. A., *Assistant Entomologist.*
C. D. Howard, B. S., *Associate Chemist.*
Frank B. Kunst, *Assistant Chemist.*
E. S. Stalnaker, B. A., *Assistant Chemist.*
Horace Atwood, M. S., *Assistant Agriculturist.*
T. C. Johnson, *Assistant Horticulturist.*
W. M. Watson, *Stenographer.*
M. A. Stewart, *Librarian.*
W. J. White, *Auditor, Clerk.*
A. R. Whitehill, Ph. D., *Treasurer.*

GENERAL OUTLOOK.

The work of the West Virginia Station during the past year has been along the same general lines pursued for a number of years. Several investigations have been completed and others have been inaugurated in their stead. On the study of the adaptability of mountain glade lands of the State for truck crops cranberries and other fruits a report has been published, and the experiments in breeding roses and carnations have been completed. Among the special features of the station work in the future will be a study of the soils and climates best suited to commercial fruit growing, with fertilizer experiments and spraying work to promote the same; bacteriological investigations of soils, of diseases of fruit trees and other plants—a work recently established at the station, for which it has ample facilities; experiments and investigations on poultry, with a study of the influence of different feeding stuffs on the flavor of meat and eggs, and experiments in raising chickens in incubators and brooders, for which the station is becoming better equipped each year, and a study of insects injurious to orchards and orchard products. The soil investigations, which have been a special feature of the station work, will be continued and amplified. Cooperative work has been arranged with the Bureau of Plant Industry of this Department on the influences of various combinations of the three important elements of plant food—nitrogen, potash, and phosphoric acid.

The financial resources of the station have been increased considerably owing to appropriations for special lines of work and the increased receipts from the fertilizer inspection, which have more than doubled during the past year. A satisfactory arrangement has been made with the State geological survey, whereby all of the analytical work of the survey is done in the laboratory of the station. This has brought additional assistance and equipment to the station and will aid it in its investigation of the soils of the State, especially in the accumulation of data for the preparation of a soil map. The legislature has made a special appropriation of $2,500 per annum for printing station bulletins and reports. The station horticulturist has resigned to accept the principalship of the Dunn County Agricultural School of Wisconsin, and has been succeeded by S. W. Fletcher, formerly of the Washington Station. The entomologist resigned to accept a position in this Department, and has been succeeded by the former assistant entomologist. Additional assistants in the departments of horticulture and chemistry have been added to the staff.

This station has made substantial progress during the year. The State has assumed the expense of publishing the station bulletins, and increased financial resources from other sources have enabled the station to improve its equipment and broaden its work in several directions. This it is doing with a good appreciation of the needs of the farming interests of the State.

LINES OF WORK.

The principal lines of work conducted at the West Virginia Station during the past year were as follows: Chemistry—study of insecticides and fungicides, including various crude petroleums, analytical work with feeding stuffs and waters, study of pressure as a preservative and of the papaw as a source of sugar and vinegar, methods of analysis; analysis and control of fertilizers; inspection of orchards and nurseries; soils—study of fertility by use of rotations, green manures, commercial fertilizers and barnyard manure, study of acid soils, soils of orchard sections, etc.; field experiments—variety tests of cereals and legumes, fertilizer experiments with buckwheat, pastures, and meadows; horticulture—adaptability of mountain glade lands for truck crops, cranberries and other fruits, study of causes of winterkilling in peach orchards, breeding roses and carnations, forcing experiments with vegetables, study of effect of cross pollination of the apple and other fruits, insecticides and fungicides for controlling San José scale, bitter rot, brown spot, frog eye, and leaf drop; feeding experiments with sheep; poultry experiments—production of meat and eggs, incubation, experiments to improve flavor of meat and eggs of domesticated fowls; and entomology—insects injurious to orchards and orchard products.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Fees	8,045.50
Farm products	436.64
Miscellaneous	120.00
Total	23,602.14

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 76–80 on the following subjects: Commercial fertilizers, the new fertilizer law, treatment for San José scale, fertilizers—part 1, sources and composition.

WISCONSIN.

Agricultural Experiment Station of the University of Wisconsin, *Madison.*

Department of the University of Wisconsin.

GOVERNING BOARD.

Board of Regents: J. H. Stout (*President*), *Menomonie;* State Superintendent of Instruction, ex officio, *Madison;* President of University, *Madison;* H. C. Taylor, *Oxfordville;* Edward Evans, *La Crosse;* James C. Kerwin, *Neenah;* Wm. F. Vilas,

STATION STAFF.

W. A. Henry, B. Agr., *Director.*
S. M. Babcock, Ph. D., *Assistant Director, Chief Chemist.*
A. R. Whitson, B. S., *Agricultural Physics.*
E. P. Sandsten, M. S., *Horticulturist.*
Frederic Cranefield, *Assistant Horticulturist.*
E. F. Farrington, M. S., *Dairy Husbandman.*
U. S. Baer, *Assistant Dairy Husbandman.*
W. L. Carlyle, B. S. A., *Animal Husbandman.*
H. L. Russell, Ph. D., *Bacteriologist.*
E. G. Hastings, *Assistant Bacteriologist.*
R. A. Moore, *Agriculturist.*
F. W. Woll, M. S., *Chemist.*
John C. Brown, M. S., *Assistant Chemist.*
F. J. Wells, *Assistant Agricultural Physicist.*
Geo. A. Olson, B. Agr., *Assistant Chemist.*
Leslie H. Adams, *Farm Superintendent.*
Ida Herfurth, *Clerk.*

GENERAL OUTLOOK.

In the work of the Wisconsin Station during the past year there have been few changes. The most important line in which expansion has taken place is that of agronomy, which is confined at present largely to work on cereals and forage plants. The work in irrigation has been somewhat curtailed, also that in soil physics. Increased attention is being given to the investigations on cheese ripening at low temperatures, which have already given important results, and the station has entered into an agreement for extensive cooperative experiments on this subject with the Bureau of Animal Industry of this Department. The station is also cooperating with the Bureau of Chemistry in sugar-beet investigations and studies of plant food in soils; with the Bureau of Plant Industry in investigations with cereals, forage, and other crops, and on the influence of origin of red-clover seed on the yield of crop, and with this Office in irrigation investigations.

Another important cooperative enterprise is that with the Short Course Experimental Association which has been organized among former students in the short courses at the university for the purpose of testing new and improved varieties and carrying on other simple experiments. Through the cooperation of this association and other farmers in the State an excellent variety of oats has been widely distributed and the use of the formaldehyde treatment for smut of oats and barley has been very widely introduced among the farmers of the State. It is estimated that from 10,000 to 20,000 farmers used the method during the past year, and the reports received from these men indicate very general success in preventing the appearance of smut. Cooperation with the Holstein-Friesian Breeders' Association and, to some extent, with the Guernsey Breeders' Association and others in testing pure-bred cows as to amount and quality of milk has been

continued. This work is done by former students under the supervision of a station officer, the actual expenses of the test being paid by the owners of the animals.

The new agricultural building, for which the legislature of 1901 appropriated $150,000, is nearing completion, but will not be occupied before spring. This building will provide quarters for the executive departments of the college of agriculture and the experiment station and for the departments of animal husbandry, agricultural chemistry, and agricultural bacteriology, besides ample room for the departments of vegetable pathology, economic entomology, and forestry, when these shall be created. The death of Prof. E. S. Goff, June 6, 1902, left a vacancy in the department of horticulture, which has recently been filled by the appointment of E. P. Sandsten, formerly of the Maryland College and Station.

The Wisconsin Station is continuing its policy of working along a few well-defined lines and is making a stronger effort than ever before to bring the results of its investigations before the people in such a way as to make them of practical use. This is being done through the various cooperative arrangements mentioned above, through regular and popular bulletins, and through farmers' institutes which are maintained by the university with an appropriation of $12,000 annually and have become very efficient means of university extension. Another feature of the State system of agricultural education is the county school of agriculture. The legislature of 1901 provided for the establishment of two such schools by the two counties which first apply for the State appropriation (not to exceed $2,500 for each school) and make provisions for erecting buildings and organizing the schools. Two counties have availed themselves of the benefit of the act and have erected buildings—Marathon County, at Wausau, and Dunn County, at Menomonie. These buildings are to accommodate both the county training schools for teachers and the agricultural schools. The course of instruction is to be of secondary grade, two years in length, and to include, besides academic branches, agriculture in its various branches, manual training, and domestic economy. It is believed that in time these schools and others that may be established will largely take the place of the short courses in the university, and thus enable the latter institution to devote its energies more largely to instruction in agriculture of collegiate grade, and to original investigations through its experiment station. Considering the amount of funds at its disposal the work of the Wisconsin Station has been remarkably effective. With the growth of the agricultural interests of the State the station could profitably use larger funds than are now at its command, and it is hoped that the university will be put in a position to enlarge the scope of the agricultural investigations conducted under its direction.

LINES OF WORK.

The principal lines of work conducted at the Wisconsin Station during the past year were as follows: Chemistry—studies of silage and of the effect of nitrates on the protein content of corn, oats, rape, and cowpeas; bacteriology—studies of silage, diseases of animals, etc.; soils—pot and field experiments with muck; field experiments—cereals and forage crops; horticulture—studies of seedling plums, effects of pinching back raspberries, etc.; feeding experiments—horses, cattle, and swine; dairying—cheese ripening at low temperatures, experiments with skim milk, condensed milk and cream; drainage; and irrigation.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
State appropriation	[a]15,000.00
Fees	1,200.00
Total	31,200.00

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 88–91 and the Annual Report for 1901. The subjects of the bulletins are dairy industry in Wisconsin; the law regulating the sale and analysis of concentrated feeding stuffs in Wisconsin; concentrated feeding stuffs and fertilizers licensed for sale in Wisconsin, 1902; oat smut in Wisconsin—prevalence and method of eradication. The Annual Report contains, in addition to data of an administrative nature, reports on the following subjects: Miscellaneous chemical work, an apparatus facilitating the analysis of sugar beets, investigation of flower buds, the influence of formalin on the germination of oats, development and distribution of nitrates in cultivated field soils, studies on black marsh soils, influence of the right amount and the right distribution of water in crop production, field experiments with grain and forage plants, causes operative in the formation of silage, influence of close packing of corn in the silo on the unavoidable losses in making silage, experiments in sugar-beet culture during 1900 and 1901, a study of certain conditions affecting the setting of fruits, third report on experiment in pinching raspberry shoots, experiments in subirrigation of flower beds, treatment of seed oats to prevent smut,

[a] Estimated amount of State appropriation for the college of agriculture and experiment station spent for experimental purposes.

the comparative value and the effect upon lamb crop of feeding various rations to ewes in winter, the food requirements of the pig for maintenance and gain, experiments in pig feeding, whole corn compared with corn meal for fattening swine, the feeding value of rape for swine, on the average composition of milk of pure-bred cows of different breeds, annual milk and butter production of cows owned by patrons of the university creamery, official tests of dairy cows, 1900–1901, the Trowbridge method of calibrating Babcock test bottles, on the increased resistance of bacteria in milk pasteurized in contact with the air, influence of cold-curing on the quality of cheese, influence of sugar on the nature of the fermentations occurring in milk and cheese, and print cheese.

WYOMING.

Wyoming Agricultural Experiment Station, *Laramie.*

Department of the University of Wyoming.

GOVERNING BOARD.

STATION STAFF.

B. C. Buffum, M. S., *Director; Agriculturist.*
Aven Nelson, M. S., M. A., *Botanist.*
E. E. Slosson, M. S., Ph. D., *Chemist.*
W. C. Knight, M. A., Ph. D., *Geologist.*
C. B. Ridgaway, M. A., *Physics.*
Burton P. Fleming, B. S., *Irrigation.*
Elias E. Nelson, M. A., *Horticulturist, Agrostologist.*
Grace R. Hebard, M. A., Ph. D., *Secretary.*

GENERAL OUTLOOK.

The principal developments in the work of the Wyoming Station during the past year have been in the lines of animal husbandry, irrigation, and agrostology. Some cooperative experiments in feeding range lambs and sheep were conducted and a beginning toward building up a herd of cattle has been made by purchasing some Shorthorns. It is the intention to extend this work, and this seems wise in view of the fact that over 73 per cent of the total value of farm products of the State is derived from animal products. Closely related to problems in animal husbandry are those concerned with the conservation and improvement of ranges and the production of crops grown under irrigation. The station is therefore experimenting on methods of producing native and introduced grasses and forage plants both on dry ranges and under irrigation, a part of this work being done in cooperation with the Bureau of Plant Industry of this Department. The irrigation work is conducted in cooperation with this Office and includes the irrigation of grasses and forage plants; a study of irrigation on

Sand Creek, a tributary of the Laramie River; a study of the water requirements of potatoes, and observations on the duty of water in actual practice as measured on farms and meadows. The station is also cooperating with the Bureau of Chemistry in sugar beet investigations and in studying the available plant food in soils. The botanist of the station is making a very thorough study of the native forage resources of the State and of methods of perpetuating and improving desirable species. He has found that among the most promising grasses for both pasture and hay are some of the brome grasses native to the State. He is also continuing a very thorough study of the native flora of the State and has published a key to the Rocky Mountain flora. One of the primary objects of the botanist's work is to encourage home making, and to this end he is seeking for native vines and other plants suitable for the decoration of home grounds. The work of the chemist in analyzing canned foods is important from the fact that so large a percentage of food consumed on ranches and in mining camps and towns is imported in cans and packages in which there are special temptations to use adulterants or preservatives. Important results have been published recently regarding the investigations in regard to the rise of alkali in soils.

At the close of the fiscal year the presidency of the university and the directorship of the station were separated, and B. C. Buffum, of the Colorado Station, but formerly agriculturist and horticulturist of the Wyoming Station, was elected director and agriculturist, to take charge September 1, 1902. The completion of the new science building gives improved office and laboratory facilities for the departments of botany, chemistry, and geology of the station, and makes more room for the departments in the main university building, in which are located the office of the director and the experiment station library. Press bulletins on a number of timely topics have been published and were very well received by the public. The station is now organized on an efficient basis and is in a position to attack several of the more important problems confronting the farmers and ranchmen of the State. It is believed that the station would be strengthened by further cooperation with the farmers and ranchmen, especially along the lines of animal husbandry, irrigation, and range improvement, but there are as yet insufficient funds for undertaking much additional work. In view of the relative importance of the animal husbandry interests the State should provide funds for carrying on further investigations along these lines.

LINES OF WORK.

The principal lines of work conducted at the Wyoming Station during the past year were as follows: Geology; botany—botanical survey, experiments with grasses, legumes, saltbushes, and other forage crops; range improvement; meteorology; waters; soils—rotations, continu-

ous cropping, cultural experiments, renovators, study of soil characteristics; fertilizers; field experiments—variety tests and cultural experiments with cereals, forage crops, and garden vegetables: analysis of foods; feeding experiments—horses, milch cows, pigs, poultry, range sheep and lambs; entomology; and irrigation—measurement of water on station farm, plat experiments, effects of irrigation on alkali.

INCOME.

The income of the station during the past fiscal year was as follows:

United States appropriation	$15,000.00
Farm products	1,157.42
Total	16,157.42

A report of the receipts and expenditures for the United States fund has been rendered in accordance with the schedules prescribed by this Department, and has been approved.

PUBLICATIONS.

The publications of this station received during the past fiscal year were Bulletins 46–49 and the Annual Report for 1901. The bulletins include reports on lamb feeding experiments and experiments in wheat culture, a study of the brome grasses of Wyoming, and a bulletin on alkali lakes and deposits, this last being Bulletin No. VI of the alkali series.

PUBLICATIONS OF THE OFFICE OF EXPERIMENT STATIONS ISSUED DURING 1902.

EXPERIMENT STATION RECORD.

Title.	Editor.
Experiment Station Record, Vol. XIII (1901–02), Nos. 4–12	E. W. Allen.
Experiment Station Record, Vol. XIV (1902–03), Nos. 1–4	Do.

ANNUAL REPORTS.

Title.	Author.
Report of the Director of the Office of Experiment Stations for 1901	A. C. True.
Annual Report of the Office of Experiment Stations for the Year ended June 30, 1901.	Do.

ARTICLES IN THE YEARBOOK OF THE UNITED STATES DEPARTMENT OF AGRICULTURE.

Some Problems of the Rural Common School. (Yearbook, 1901, pp. 133–154)	A. C. True.
Dietaries in Public Institutions. (Yearbook, 1901, pp. 393–408)	W. O. Atwater.
Some Typical Reservoirs in the Rocky Mountain States. (Yearbook, 1901, pp. 415–430).	E. Mead.

BULLETINS.

Number.	Title.	Author.
Bulletin 103	The Evolution of Reaping Machines	M. F. Miller.
Bulletin 104	Report of Irrigation Investigations for 1900	E. Mead et al.
Bulletin 105	Irrigation in the United States	E. Mead.
Bulletin 106	Results of Investigations on the Rothamsted Soils	B. Dyer.
Bulletin 107	Nutrition Investigations among Fruitarians and Chinese at the California Agricultural Experiment Station, 1899-1901.	M. E. Jaffa.
Bulletin 108	Irrigation Practice among Fruit Growers on the Pacific Coast.	E. J. Wickson.
Bulletin 109	Experiments on the Metabolism of Matter and Energy in the Human Body, 1898-1900.	W. O. Atwater, F. G. Benedict, et al.
Bulletin 110	Proceedings of the Sixth Annual Meeting of the American Association of Farmers' Institute Workers, held at Buffalo, N. Y., September 18 and 19, 1901.	A. C. True, D. J. Crosby, and G. C. Creelman.
Bulletin 111	Organization Lists of the Agricultural Colleges and Experiment Stations in the United States, with a List of Agricultural Experiment Stations in Foreign Countries, March, 1902.	D. J. Crosby and M. T. Spethmann.
Bulletin 112	Agricultural Experiment Stations in Foreign Countries	A. C. True and D. J. Crosby.
Bulletin 113	Irrigation of Rice in the United States	F. Bond and G. H. Keeney.
Bulletin 114	Statistics of the Land-Grant Colleges and Agricultural Experiment Stations of the United States for the Year Ended June 30, 1901.	M. T. Spethmann.
Bulletin 115	Proceedings of the Fifteenth Annual Convention of the Association of American Agricultural Colleges and Experiment Stations, held at Washington, D. C., November 12-14, 1901.	A. C. True, W. H. Beal, and H. H. Goodell.
Bulletin 116	Dietary Studies in New York City in 1896 and 1897	W. O. Atwater and A. P. Bryant.
Bulletin 117	Experiments on the Effect of Muscular Work on the Digestibility of Food and the Metabolism of Nitrogen.	C. E. Wait.
Bulletin 118	Irrigation from Big Thompson River	J. E. Field.
Bulletin 119	Report of Irrigation Investigations for 1901	E. Mead et al.
Bulletin 120	Proceedings of the Seventh Annual Meeting of the American Association of Farmers' Institute Workers, held at Washington, D. C., June 24-26, 1902.	A. C. True, D. J. Crosby, and G. C. Creelman.

FARMERS' BULLETINS.[a]

Bulletin 142	Principles of Nutrition and Nutritive Value of Food	W. O. Atwater.
Bulletin 144	Experiment Station Work, XIX	W. H. Beal, editor.
Bulletin 149	Experiment Station Work, XX	Do.
Bulletin 158	How to Build Small Irrigation Ditches	C. T. Johnston and J. D. Stannard.

CIRCULARS.

Circular 47	Card Index of Experiment Station Literature	A. C. True.
Circular 48	What the Department of Agriculture is Doing for Irrigation.	E. Mead.
Circular 49	Secondary Courses in Agriculture	A. C. True et al.

[a] These are published as part of a general series issued by the United States Department of Agriculture.

STATION PUBLICATIONS RECEIVED BY THE OFFICE OF EXPERIMENT STATIONS DURING 1902.[a]

ALABAMA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 117	Orchard Notes	C. F. Austin.
Annual Report	Fourteenth Annual Report, 1901	
Index, Vol. IX	Index to Bulletins 113-117, Fourteenth Annual Report	
1902.		
Bulletin 118	Cowpea Culture	J. F. Duggar.
Bulletin 119	The Flora of the Metamorphic Region of Alabama	F. S. Earle.
Bulletin 120	The Cowpea and the Velvet Bean as Fertilizers	J. F. Duggar.

ALASKA STATIONS.

1901.		
Annual Report	Annual Report, 1901	C. C. Georgeson.
1902.		
Bulletin 1	Suggestions to Pioneer Farmers in Alaska	Do.

ARIZONA STATION.

1902.		
Index, Vol. I	Index to Bulletins 1-25, Annual Reports, 1890-1897	
Index, Vol. II	Index to Bulletins 26-32, Annual Reports, 1898-99	
Bulletin 40	Soil Survey in Salt River Valley	T. H. Means.
Bulletin 41	Irrigation at the Station Farm, 1898-1901	A. J. McClatchie.
Bulletin 42	The Cool Side of a House in Arizona	S. N. Woodward.
Bulletin 43	Utilizing Our Water Supply	A. J. McClatchie.
Bulletin 44	The River-Irrigated Waters of Arizona—Their Character and Effects.	R. H. Forbes.
Bulletin 45	Timely Hints for Farmers	

ARKANSAS STATION.

1901.		
Bulletin 67	Investigations of Swine Diseases in Arkansas	R. R. Dinwiddie.
Bulletin 68	Soil Improvement and Forage Experiments	R. L. Bennett.
Bulletin 69	Some Muskmelon Experiments	E. Walker.
Bulletin 70	Cowpea Experiments	C. L. Newman.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 71	Why Apple Trees Fail	E. Walker.
Bulletin 72	Sweet Potato Experiments	C. L. Newman.
Bulletin 73	Pork Production Experiments and Hog Ranching	R. L. Bennett.
Bulletin 74	The Phosphate Rocks of Arkansas	J. C. Branner and J. F. Newsom.
Bulletin 75	Alfalfa	R. L. Bennett.

CALIFORNIA STATION.

1901.		
Report	Report 1899-1900—Part I	
Do.	Report 1899-1900—Part II	
1902.		
Bulletin 123 and	Olives: Composition and Adaptations	G. E. Colby.
137 (Revised)	Olives: Cultivation, Oil Making, Pickling, and Diseases	F. T. Bioletti.
Bulletin 138	Citrus Fruit Culture	J. W. Mills.

[a] A list of publications issued by the stations prior to January 1, 1892, was published in the Experiment Station Record, Vol. III, p. 937; and lists of those issued in subsequent years in the following bulletins of the Office of Experiment Stations: 1892 and 1893, Bulletin 19, p. 61; 1894, Bulletin 23, p. 58; 1895, Bulletin 27, p. 59; 1896, Bulletin 39, p. 58; 1897, Bulletin 47, p. 57; 1898, Bulletin 59, p. 74; 1899, Bulletin 74, p. 79; 1900, Bulletin 88, p. 89, and 1901, Bulletin 111, p. 74. A list of the publications issued by the stations from 1875 to 1899 was published in Bulletin 80, p. 512, of the Office of Experiment Stations.

CALIFORNIA STATION—Continued.

Publication.	Title.	Author.
1902.		
Bulletin 139	Orange and Lemon Rot	C. W. Woodworth.
Bulletin 140	Lands of the Colorado Delta in the Salton Basin	F. J. Snow, E. W. Hilgard, and G. W. Shaw.
Bulletin 141	Experiments with Deciduous Fruits at and Near the Southern Coast Range Substation, Paso Robles, from 1889 to 1902.	C. H. Shinn.
Bulletin 142	Grasshoppers in California	C. W. Woodworth.
Bulletin 143	The California Peach-Tree Borer	Do.
Bulletin 144	The Peach Worm	W. T. Clarke.

COLORADO STATION.

Publication.	Title.	Author.
1901.		
Bulletin 65	A Soil Study: III. The Soil	W. P. Headden.
Bulletin 66	Relation of Bovine to Human Tuberculosis	G. H. Glover.
	Tuberculin Tests of the College Herd	B. C. Buffum.
Bulletin 67	The Distribution of Water. Powers and Duties of Irrigation Officials under Colorado Laws.	H. N. Haynes.
1902.		
Bulletin 68	Pasture Grasses. Leguminous Crops. Cantaloupe Blight.	H. H. Griffin.
Bulletin 69	Plant Diseases of 1901	W. Paddock.
Bulletin 70	Potato Failures	F. M. Rolfs.
Bulletin 71	Insects and Insecticides	C. P. Gillette.
Bulletin 72	A Soil Study: IV. The Ground Water	W. P. Headden.
Bulletin 73	The Feeding Value of Beet Pulp. Feeding Beet Pulp and Sugar Beets to Cows.	B. C. Buffum and C. J. Griffith.
Bulletin 74	Swine Feeding in Colorado	Do.
Bulletin 75	Lamb Feeding Experiments	Do.
Bulletin 76	Feeding Beet Pulp to Lambs	H. H. Griffin.

CONNECTICUT STATE STATION.

Publication.	Title.	Author.
1901.		
Annual Report	Annual Report, 1901—Parts II, III, and IV	
1902.		
Bulletin 136	Preliminary Experiments in Spraying to Kill the San José Scale Insect, Season of 1901.	W. E. Britton.
Bulletin 137	The Growing of Tobacco Under Shade in Connecticut	E. H. Jenkins.
Bulletin 138	Commercial Feeding Stuffs in the Connecticut Market	
Bulletin 139	The Apple-Tree Tent Caterpillar	W. E. Britton.
Bulletin 140	The White Fly or Plant-House Aleyrodes	Do.
Annual Report	Annual Report, 1902—Part I	

CONNECTICUT STORRS STATION.

Publication.	Title.	Author.
1900.		
Annual Report	Thirteenth Annual Report, 1900	
1902.		
Bulletin 23	The Relation of Bovine Tuberculosis to that of Man, and its Significance in the Dairy Herd.	H. W. Conn.
	Results of Experiments with Tuberculous Cows and the Use of Their Milk in Feeding Calves.	C. S. Phelps.
Bulletin 24	The History of a Tuberculous Herd of Cows	C. L. Beach.

DELAWARE STATION.

Publication.	Title.	Author.
1901.		
Bulletin 53	Three Orchard Pests: I. The Apple-Bud Borer. II. The Fruit-Tree Bark-Borer. III. The Periodical Cicada.	E. D. Sanderson.
Annual Report	Thirteenth Annual Report, 1901	
1902.		
Bulletin 54	The Chinese Cling Group of Peaches	G. H. Powell.
Bulletin 55	Alfalfa, Cowpeas, and Crimson Clover as Factors in Reducing Feed Bills.	
	A Critical Study of Getty's Method of Raising Cowpeas for Silage Purposes.	A. T. Neale.
Bulletin 56	Some Destructive Caterpillars	E. D. Sanderson.
Bulletin 57	Sundry Notes on Plant Diseases	F. D. Chester.

FLORIDA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 59	Cauliflower	H. H. Hume.
Annual Report	Annual Report, 1901	
1902.		
Bulletin 60	Velvet Bean	H. K. Miller.
Bulletin 61	Two Peach Scales	H. A. Gossard.
Bulletin 62	The Peen-to-Peach Group	H. H. Hume.
Bulletin 63	Packing Citrus Fruits	Do.

GEORGIA STATION.

1901.		
Bulletin 53	Second Report on Grapes	A. L. Quaintance.
Bulletin 54	The Pickle Worm	Do.
Bulletin 55	Corn Culture	R. J. Redding.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 56	Cotton Culture	Do.
Bulletin 57	Cantaloupe Culture in Georgia	S. H. Fulton.

HAWAII STATION.

1901.		
Bulletin 1	Chickens and Their Diseases in Hawaii	T. F. Sedgwick.
Annual Report	Annual Report, 1901	J. G. Smith.

HAWAIIAN SUGAR PLANTERS' STATION.

1895.		
Report	Reports: On Soils; Fertilization; and Fermentation of Sugars.	W. Maxwell.
1898.		
Report	Lavas and Soils of the Hawaiian Islands	Do.
Do	Reports on Fertilization and Work of the Experiment Station Laboratory.	Do.
1899.		
Report	Work of the Experiment Station and Laboratories, 1899	Do.
1900.		
Report	Work of the Experiment Station and Laboratories, 1900	Do.
1901.		
Report	Report on Fertilization	C. F. Eckart.
Do	Work of the Experiment Station and Laboratories, 1901	R. E. Blouin.
1902.		
Report	Report on Precautions to be Observed with Regard to Cane Importations.	C. F. Eckart.
Do	Work of the Experiment Station and Laboratories, 1902	Do.

IDAHO STATION.

1901.		
Bulletin 30	The Service of Soils	F. A. Huntley.
Annual Report	Annual Report, 1901	
1902.		
Bulletin 31	Some Spraying Experiments for 1901	L. F. Henderson.
Bulletin 32	Steer Feeding. Feeding Lambs. Analysis of Stock Foods.	H. T. French.
Bulletin 33	Some Grasses and Clovers and How to Grow them in Idaho.	Do.

ILLINOIS STATION.

Publication.	Title.	Author.
1901.		
Bulletin 66	Individual Differences in the Value of Dairy Cows	W. J. Fraser.
Bulletin 67	Apple Scab	G. P. Clinton.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 68	Important Details of Spraying	A. V. Steubenrauch.
Bulletin 69	Apple Rots in Illinois	G. P. Clinton.
Bulletin 70	Canker of Apple Trees	H. Hasselbring.
Bulletin 71	Experiments with Insecticides for the San José Scale	S. A. Forbes.
Bulletin 72	Additional Insecticide Experiments for the San José Scale.	Do.
Bulletin 73	Comparison of Silage and Shock Corn for Wintering Calves Intended for Beef Production.	H. W. Mumford.
Bulletin 74	Standard Milk and Cream	W. J. Fraser.
Bulletin 75	Standardization of Milk and Cream	O. Erf.
Bulletin 76	Alfalfa on Illinois Soils	C. G. Hopkins.
Bulletin 77	Bitter Rot of Apples	T. J. Burrill and J. C. Blair.
Bulletin 78	Market Classes and Grades of Cattle, with Suggestions for Interpreting Market Quotations.	H. W. Mumford.
Bulletin 79	The Corn Bill-Bugs in Illinois	S. A. Forbes.
Bulletin 80	Methods and Results of Field Insecticide Work against the San José Scale, 1899-1902.	Do.
Bulletin 81	Forcing Tomatoes	A. C. Beal.

INDIANA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 90	Tankage as a Food for Pigs	C. S. Plumb and H. E. Van Norman.
Annual Report	Fourteenth Annual Report, 1901	
1902		
Bulletin 91	The Modern Silo	C. S. Plumb.
Bulletin 92	Fertilizer Tests on Tomatoes	H. A. Huston.
Bulletin 93	The Influence of Condimental Stock Food in Fattening Swine.	C. S. Plumb.

IOWA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 60	The Aphididæ of North America	W. D. Hunter.
Bulletin 61	Miscellaneous Notes on Fungus Diseases. The Canadian Thistle and Dandelion.	L. H. Pammel.
	A few of the Common Fleshy Fungi of Ames	A. W. Hess.
Bulletin 62	A Study on the Germination and Growth of Leguminosæ, Especially with Reference to Small and Large Seed.	F. G. Miller and H. L. Pammel.
Biennial Report	Nineteenth Biennial Report, 1900-1901	
1902.		
Bulletin 63	Sheep-Feeding Experiments	W. J. Kennedy and F. R. Marshall.
Bulletin 64	Notes on Strawberries	H. C. Price and E. E. Little.
Bulletin 65	The Results on Swine-Feeding Experiments	W. J. Kennedy and F. R. Marshall.
Bulletin 66	The Results of a Cattle-Feeding Test	Do.

KANSAS STATION.

Publication.	Title.	Author.
1901.		
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 106	The Experimental Apple Orchard	A. Dickens and G. O. Greene.
Bulletin 107	Analyses of Corn, with Reference to Its Improvement	J. T. Willard, R. W. Clothier, and F. C. Weber.
Bulletin 108	The Hardy Catalpa	H. F. Roberts.
Bulletin 109	Spontaneous Combustion of Alfalfa	H. M. Cottrell.
Bulletin 110	Grapes	A. Dickens and G. O. Greene.

KANSAS STATION—Continued.

Publication.	Title.	Author.
1902.		
Bulletin 111	Quality in Beef	H. M. Cottrell and V. M. Shoesmith.
Bulletin 112	Fattening Steers without Hogs to Follow	H. M. Cottrell and J. G. Haney.
Bulletin 113	Baby Beef	H. M. Cottrell, J. G. Haney, and O. H. Elling.
Bulletin 114	Growing Alfalfa in Kansas	H. M. Cottrell.
Annual Report	Fifteenth Annual Report, 1902	

KENTUCKY STATION.

Publication.	Title.	Author.
1901.		
Bulletin 96	The Hessian Fly; Dangerous Mosquitoes in Kentucky; Poisonous and Edible Mushrooms.	H. Garman.
Bulletin 97	Commercial Fertilizers	M. A. Scovell, A. M. Peter, and H. E. Curtis
1902.		
Bulletin 98	Kentucky Forage Plants—The Clovers and Their Allies; Notes on Two Grasses in the Plats in 1900-1901.	H. Garman.
	Analyses of Forage Plants from the Plats	A. M. Peter.
Bulletin 99	Oats	J. N. Harper and A. M Peter.
Bulletin 100	Inspection and Analyses of Food	M. A. Scovell and R McD. Allen.
Bulletin 101	A Comparison of Feeds for Pigs	D. W. May.
Bulletin 102	Commercial Fertilizers	

LOUISIANA STATIONS.

Publication.	Title.	Author.
1901.		
Bulletin 65	Analyses of Commercial Fertilizers and Paris Green	W. C. Stubbs.
Bulletin 66	Sugar Cane: Experiments in Cultivation	Do.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 67	Broom Corn	W. R. Dodson.
Bulletin 68	Home-Grown *v.* Purchased Seed	W. C. Stubbs, F. H. Burnette, and E. Watson.
Report	Geology and Agriculture. VI. A Report on the Geology of Louisiana.	G. D. Harris, A. C. Veatch, and J. A. A. Pacheco.
Bulletin 69	Pecans	F. H. Burnette, W. C. Stubbs, and H. A. Morgan.
Bulletin 70	Cane Borer	W. C. Stubbs and H. A. Morgan.
Bulletin 71	Annual Report of North Louisiana Experiment Station, 1901.	D. N. Barrow.

MAINE STATION.

Publication.	Title.	Author.
1901.		
Bulletin 78	Finances, Meteorology, Index	
Annual Report	Seventeenth Annual Report, 1901	
1902.		
Bulletin 79	Poultry Experiments in 1900 and 1901	G. M. Gowell.
Bulletin 80	Feeding Stuff Inspection	C. D. Woods and J. M. Bartlett.
Bulletin 81	Fertilizer Inspection	Do.
Bulletin 82	Orchard Notes	W. M. Munson.
Bulletin 83	The Grass Thrips	L. R. Cary.
Bulletin 84	Cereal Breakfast Foods	L. H. Merrill and E. R. Mansfield.
Bulletin 85	Fertilizer Inspection	C. D. Woods and J. M. Bartlett.
Bulletin 86	Variation in *Trillium grandiflorum*	H. W. Britcher.

MARYLAND STATION.

Publication.	Title.	Author.
1901.		
Bulletin 78	The Dehorning of Stock	C. F. Doane.
1902.		
Bulletin 79	The Disinfecting Properties of Washing Powders	Do.
Bulletin 80	Acute Epizootic Leucoencephalitis in Horses	W. G. McCallum and S. S. Buckley.
Bulletin 81	Soils and Fertilizers for Greenhouse Crops	H. J. Patterson and T. H. White.
Bulletin 82	Thinning Fruits	E. P. Sandsten.
Bulletin 83	Investigations as to the Cause of Pithiness in Celery	E. P. Sandsten and T. H. White.
Bulletin 84	Some Feeding Experiments with Cows	H. J. Patterson.
Bulletin 85	Alfalfa for Maryland	W. T. Taliaferro.
Bulletin 86	The Influence of Preservatives upon the Food Value of Milk.	C. F. Doane and T. M. Price.
Annual Report	Fifteenth Annual Report, 1902	

MASSACHUSETTS STATION.

Publication.	Title.	Author.
1901.		
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 78	Concentrated Feed Stuffs	J. B. Lindsey et al.
Bulletin 79	Growing China Asters	R. E. Smith.
Bulletin 80	Fungicides, Insecticides, Spraying Calendar	G. E. Stone, H. E. Fernald, and S. T. Maynard.
Bulletin 81	Fertilizers	C. A. Goessmann.
Bulletin 82	Orchard Management; Cover Crops in Orchards; Pruning of Orchards; Report on Fruits.	S. T. Maynard and G. A. Drew.
Bulletin 83	Analyses of Commercial Fertilizers and Manurial Substances.	C. A. Goessmann.
Bulletin 84	Analyses of Fertilizers	Do.
Meteorological bulletins.	Meteorological Bulletins 157-161	J. E. Ostrander and H. L. Bodfish.
	Meteorological Bulletins 162-168	J. E. Ostrander and S. C. Bacon.

MICHIGAN STATION.

Publication.	Title.	Author.
1901.		
Bulletin 193	Some Experiments with Beet Pulp as a Stock Food	C. D. Smith.
Bulletin 194	Report of South Haven Substation for 1901	S. H. Fulton.
Special Bulletin 14.	Foul Brood	C. D. Smith and J. M. Rankin.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Special Bulletin 15.	Spraying Calendar	L. R. Taft.
Special Bulletin 16.	Aeration of Milk	C. E. Marshall.
Bulletin 195	Strawberry Notes for 1901	L. R. Taft and M. L. Dean.
Bulletin 196	Notes on Vegetables	Do.
Bulletin 197	Sugar-Beet Experiments, 1901	J. D. Towar.
Bulletin 198	Sand Lucern	Do.
Bulletin 199	Cowpeas, Soy Beans, and Winter Vetch	Do.
Bulletin 200	Some Insects of the year 1901	R. H. Pettit.
Bulletin 201	Aeration of Milk	C. E. Marshall.
Bulletin 202	Fertilizer Analyses	R. C. Kedzie and F. W. Robison.

MINNESOTA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 72	Prairie Forestry and Horticulture at Coteau Farm	S. B. Green.
Annual Report	Ninth Annual Report, 1901	
1902.		
Bulletin 73	Growing Swine of Various Breeds and Crosses	T. Shaw.
Bulletin 74	Human Food Investigations	H. Snyder.

MISSISSIPPI STATION.

Publication.	Title.	Author.
1901.		
Bulletin 68	Analyses of Commercial Fertilizers on Sale in the State	W. F. Hand et al.
Bulletin 69	Texas Fever	J. C. Robert.
Bulletin 70	Records of Station Cows. Feeding Dairy Cows	J. S. Moore.
1902.		
Bulletin 71	Milk Fever	J. C. Robert.
Bulletin 72	Anthrax	Do.
Bulletin 73	Tick Fever or Murrain in Southern Cattle	Do.
Bulletin 74	Some Mosquitoes of Mississippi and How to Deal with Them.	G. W. Herrick.
Bulletin 75	Strawberry Culture in Mississippi	A B. McKay.
Bulletin 76	Beef Cattle	W. L. Hutchinson and E R. Lloyd.
Bulletin 77	Analyses of Commercial Fertilizers on Sale in the State	W. L. Hutchinson.
Annual Report	Fifteenth Annual Report, 1902	

MISSOURI FRUIT STATION.

Publication.	Title.	Author.
1902.		
Bulletin 2	Notes on Spraying for Bitter Rot	J. T. Stinson.
Bulletin 3	Varieties of Apples and Peaches	Do.

MISSOURI STATION.

Publication.	Title.	Author.
1902.		
Bulletin 51	The Chinch Bug	J. M. Stedman.
Bulletin 52	Influence of Height of Wheel on the Draft of Farm Wagons.	T. I. Mairs.
Bulletin 53	Breeding Experiments with Sheep	F. B. Mumford.
Bulletin 56	Dairy Husbandry	

MONTANA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 32	Eighth Annual Report, 1901	
1902.		
Bulletin 33	Sugar Beets in Montana, the Crop of 1901	F. W. Traphagen.
Bulletin 34	Farmers' Weirs	S. Fortier.
Bulletin 35	Beef Cattle and Sheep	R. S. Shaw.
Bulletin 36	Forage Conditions of Central Montana	F. A. Spragg.

NEBRASKA STATION.

Publication.	Title.	Author.
1901.		
Annual Report	Fifteenth Annual Report, 1901	
1902.		
Bulletin 72	The Adaptation and Improvement of Winter Wheat	T. L. Lyon.
Bulletin 73	Experiments in the Culture of the Sugar Beet in Nebraska.	T. L. Lyon and A. T. Wiancko.
Bulletin 74	Mange in Cattle and Horses and Lice on Hogs.	A. T. Peters.
Bulletin 75	Feeding Experiments with Cattle and Pigs	E. A. Burnett and H. R. Smith.

NEVADA STATION.

Publication.	Title.	Author.
1901.		
Bulletin 51	A Preliminary Report on the Summer Ranges of Western Nevada Sheep.	P. B. Kennedy and S. B. Doten.
1902.		
Bulletin 52	Water Supply and Irrigation in Nevada	L. H. Taylor.
Bulletin 53	The Burning of Dead Animals	R. H. McDowell.

NEW HAMPSHIRE STATION.

Publication.	Title.	Author.
1901.		
Bulletin 84	Forcing Dwarf Tomatoes under Glass	F. W. Rane.
Bulletin 85	Remedies for the Cankerworm	C. M. Weed.
Bulletin 86	Growing Watermelons in the North. Classification of Watermelons.	F. W. Rane.
Bulletin 87	Thirteenth Annual Report, 1901	
Technical Bulletin 3.	The Food of the Myrtle Warbler	C. M. Weed and M. Dearborn.
1902.		
Bulletin 88	Inspection of Fertilizers in 1901	F. W. Morse.
Bulletin 89	The Squash Bug	C. M. Weed and A. F. Conradi.
Bulletin 90	Insect Record for 1901	C. M. Weed.
Bulletin 91	Killing Woodchucks with Carbon Bisulphid	Do.
Bulletin 92	Silage Studies	F. W. Morse.
Bulletin 93	The Cold Storage of Apples	F. W. Rane, H. H. Lamson, and F. W. Morse.

NEW JERSEY STATIONS.

1900.		
Annual Report	Twenty-First Annual Report of the State Station and Thirteenth Annual Report of the College Station, 1900.	
1901.		
Bulletin 154	Analyses of Commercial Fertilizers	L. A. Voorhees and J. P. Street.
Annual Report	Twenty-Second Annual Report of the State Station and Fourteenth Annual Report of the College Station, 1901.	
1902.		
Bulletin 155	The Entomologist's Experiment Orchard	J. B. Smith.
Bulletin 156	Cattle Food Substitutes	L. A. Voorhees.
	A Warning to Feeders	J. P. Street.
Bulletin 157	Field Experiments with Nitrate of Soda on Market Garden Crops.	E. B. Voorhees.
Bulletin 158	Soiling Crop Experiments	C. B. Lane.
Bulletin 159	The Rose Scale	J. B. Smith.
Bulletin 160	Concentrated Feeding Stuffs	L. A. Voorhees and J P. Street.
Bulletin 161	Alfalfa, Cowpeas, and Crimson Clover as Substitutes for Purchased Feeds. Home-Grown Protein *v.* Purchased Protein.	C. B. Lane.
Special Bulletin T.	The Salt-Marsh Mosquito	J. B. Smith.

NEW MEXICO STATION.

1901.		
Bulletin 40	A Southern New Mexico Flower Garden	F. E. Lester.
Annual Report	Twelfth Annual Report, 1901	
1902.		
Bulletin 41	Spraying Orchards for the Codling Moth	F. Garcia.
Bulletin 42	Alkali	J. D. Tinsley.
Bulletin 43	Drainage and Flooding for the Removal of Alkali	Do.

NEW YORK STATE STATION.

1900		
Annual Report	Nineteenth Annual Report, 1900	
1901.		
Bulletin 201	Report of Analyses of Commercial Fertilizers for the Spring and Fall of 1901.	L. L. Van Slyke and W. H. Andrews.
Bulletin 202	San José Scale Investigations	V. H. Lowe and P. J. Parrott.
Bulletin 203	A Study of Enzyms in Cheese	L. L. Van Slyke, H. A. Harding, and E. B. Hart.
Bulletin 204	Report of Analyses of Paris Green and other Insecticides in 1901.	L. L. Van Slyke and W. H. Andrews.
Bulletin 205	Influence of Manure on Sugar Beets	W. H. Jordan and G. W. Churchill.
Bulletin 206	Commercial Fertilizers for Onions	W. H. Jordan and F. A. Sirrine.

NEW YORK STATE STATION—Continued.

Publication.	Title.	Author.
1901.		
Bulletin 207	Conditions Affecting Weight Lost by Cheese in Curing	L. L. Van Slyke.
Bulletin 208	Stable Manure and Nitrogenous Chemical Fertilizers for Forcing Lettuce.	S. A. Beach and H. Hasselbring.
Bulletin 209	Treatment for San José Scale in Orchards—I. Orchard Fumigation.	F. A. Sirrine.
Bulletin 210	The Immediate Effect on Milk Production of Changes in the Ration.	W. P. Wheeler.
Bulletin 211	Director's Report for 1901	W. H. Jordan.
1902.		
Bulletin 212	Miscellaneous Notes on Injurious Insects	V. H. Lowe.
Bulletin 213	Treatment for San José Scale in Orchards—II. Spraying with Kerosene and Crude Petroleum.	F. A. Sirrine.
Bulletin 214	A Study of Some of the Salts Formed by Casein and Paracasein with Acids: Their Relations to American Cheddar Cheese.	L. L. Van Slyke and E. D. Hart.
Bulletin 215	Methods for the Estimation of the Proteolytic Compounds Contained in Cheese and Milk.	Do.
Bulletin 216	Report of Analyses of Commercial Fertilizers for the Spring and Fall of 1902.	L. L. Van Slyke and W. H. Andrews.

NEW YORK CORNELL STATION.

1901.		
Bulletin 197	Investigations Concerning the Germicidal Action in Cow's Milk.	O. F. Hunziker.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 198	Orchard Cover Crops	J. Craig.
Bulletin 199	Separator Skimmed Milk as Food for Pigs	L. A. Clinton.
Bulletin 200	Muskmelons	J. Craig.
Bulletin 201	Buying and Using Commercial Fertilizers	L. A. Clinton.
Bulletin 202	Trap Lanterns, or "Moth Catchers"	M. V. Slingerland.
Bulletin 203	The Care and Handling of Milk	O. F. Hunziker.
Bulletin 204	Cooperative Experiments and Cost of Egg Production	H. H. Wing.
Bulletin 205	Shade Trees	W. A. Murrell.
Bulletin 206	Sixth Report of Extension Work	J. Craig.
Bulletin 207	Pink Rot, an Attendant of Apple Scab	J. Craig and J. M. Van Hook.

NORTH CAROLINA STATION.

1902.		
Bulletin 181	Silk Culture	G. McCarthy.

NORTH DAKOTA STATION.

1901.		
Bulletin 49	Some Points on Fruit Culture	C. B. Waldron.
Bulletin 50	Flax Wilt and Flax Sick Soil	H. L. Bolley.
Annual Report	Twelfth Annual Report, 1901	
1902.		
Bulletin 51	Corn Culture	J. H. Shepperd and A. M. Ten Eyck.
Bulletin 52	The Length of the Growing Season in North Dakota	E. F. Ladd, J. H. Shepperd, and A. M. Ten Eyck.

OHIO STATION.

1901.		
Bulletin 127	Miscellaneous Chemical Analyses	A. D. Selby and J. W. Ames.
Bulletin 128	Meteorological Summary	C. A. Patton.
	Press Bulletin—Index	
	Twentieth Annual Report, 1901	
Bulletin 128 (Index Supplement).	General Index to Reports and Bulletins, Vols. I-XX, 1882-1901.	

OHIO STATION—Continued.

Publication.	Title.	Author.
1902.		
Bulletin 130	Spraying for Grape Rot	A. D. Selby and J. F. Hicks.
	The Relation of Grape Spraying to Public Health	A. D. Selby.
Bulletin 131	The Prevention of Onion Smut	Do.
Bulletin 132	Sugar-Beet Investigations in 1901	J. W. Ames.
Bulletin 133	Potatoes	W. J. Green and C. W. Waid.
Bulletin 134	The Value of Barnyard Manure	C. E. Thorne and J. F. Hickman.

OKLAHOMA STATION.

1901.		
Bulletin 51	Feeding Cotton-Seed Meal to Hogs	F. C. Burtis and J. S. Malone.
Bulletin 52	The Potato Crop. Variety Tests of Cabbage	O. M. Morris.
1902.		
Bulletin 53	Common Parasites of Domestic Animals	L. L. Lewis.
Bulletin 54	The Improvement of the Castor Plant	W. R. Shaw.
Annual Report	Eleventh Annual Report, 1902	

OREGON STATION.

1902.		
Bulletin 68	Annotated List of the Birds of Oregon	A. R. Woodcock.
Bulletin 69	The Codling Moth and Late Spraying in Oregon	A. B. Cordley.
Bulletin 70	Testing Milk and Cream	F. L. Kent.
Bulletin 71	Stagnant Water Germs in Milk	E. F. Pernot.
Bulletin 72	Preliminary Report on Steamed Silage	J. Withycombe and A. L. Kniseley.
Annual Report	Annual Report, 1902	

PENNSYLVANIA STATION.

1901.		
Bulletin 57	Methods of Steer Feeding	G. C. Watson and A. K. Risser.
Annual Report	Annual Report, 1901	
1902.		
Bulletin 58	Weeds in General: Two Newcomers into Pennsylvania	W. A. Buckhout.
Bulletin 59	Pennsylvania Sugar Beets in 1901	W. Frear and W. T. Carter.
Bulletin 60	The Rearing of Calves on Milk Substitutes	H. Hayward.

PORTO RICO STATION.

1901.		
Annual Report	Annual Report, 1901	F. D. Gardner.
Bulletin 1	The Agricultural Experiment Station of Porto Rico: Its Establishment, Location, and Purpose.	Do.
Bulletin 2	The Changa or Mole Cricket in Porto Rico	O. W. Barrett.

RHODE ISLAND STATION.

1902.		
Bulletin 82	Grass Experiments	H. J. Wheeler and G. E. Adams.
Bulletin 83	Improving an Orchard	F. W. Card.
Bulletin 84	Poultry Feeding. Feeding Stuffs	H. J. Wheeler.
Bulletin 85	Analyses of Commercial Fertilizers	H. J. Wheeler, B. L. Hartwell, et al.

SOUTH CAROLINA STATION.

Publication.	Title.	Author.
1901.		
Annual Report	Annual Report, 1901	
1902.		
Bulletin 66	Feeding Corn Stover. Dehorning Milch Cows	C. M. Conner.
Bulletin 67	Stock Feeding	Do.
Bulletin 68	A Chemical Study with Sea Island Cotton Seed	F. S. Shiver.
Bulletin 69	Brown Rot of Peaches and Plums	C. C. Newman.
Bulletin 70	Analyses of Commercial Fertilizers	
Bulletin 71	New Method of Preserving Sweet Potatoes	J. S. Newman and J. S. Pickett.

SOUTH DAKOTA STATION.

1901.		
Bulletin 72	Ornamentals for South Dakota	N. E. Hansen.
1902.		
Bulletin 73	Variations in Cream and Milk Tests	A. H. Wheaton.
Bulletin 74	Drought-Resistant Forage Experiments at Highmore Substation.	D. A. Saunders.

TENNESSEE STATION.

1901.		
Bul. Vol. XIV, No. 3	Winter Cereals and Legumes	A. M. Soulé and P. O. Vanatter.
Bul. Vol. XIV, No. 4	The Early Growth and Training of Apple Trees	C. A. Keffer.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bul Vol. XV, No. 1.	The Value of Corn, Skim Milk, and Whey for Fattening Swine.	A. M. Soulé and J. R. Fain.
Bul. Vol. XV, No. 2.	The Action of Copper on Leaves	S. M. Bain.
Bul. Vol. XV, No. 3.	Feeding Native Steers	A. M. Soulé and J. R. Fain.
Bul. Vol. XV, No. 4.	The Relative Value of Protein in Cotton-Seed Meal, Cowpea Hay and Wheat Bran.	A. M. Soulé and S. E. Barnes.

TEXAS STATION.

1901.		
Bulletin 61	Willis and Huntsville Tobacco Soils	H. H. Harrington and P. S. Tilson.
Bulletin 62	The Fig	R. H. Price and E. A. White.
Annual Report	Thirteenth Annual Report, 1901	
1902.		
Bulletin 63	Texas Fever	M. Francis.
Bulletin 64	Insect Pests Attacking Truck Crops	F. W. Mally.

UTAH STATION.

1901.		
Bulletin 73	Experiments in Butter Making and Cheese Making	F. B. Linfield.
Annual Report	Twelfth Annual Report, 1901	
1902.		
Bulletin 74	Lead Ore in Sugar-Beet Pulp	J. A. Widtsoe and L. A. Merrill.
Bulletin 75	Arid Farming, or Farming Without Irrigation	Do.
Bulletin 76	Forcing Lettuce	C. P. Close.
Bulletin 77	Horse Feeding	L. A. Merrill.

VERMONT STATION.

Publication.	Title.	Author.
1901.		
Bulletin 88	Analyses of Commercial Feeding Stuffs	J. L. Hills, C. H. Jones, and B. O. White.
Bulletin 89	Plum Culture	F. A. Waugh.
Bulletin 90	Apple Growing in Madison County	F. A. Waugh and M. B. Cummings.
Annual Report	Fourteenth Annual Report, 1901	
1902.		
Bulletin 91	Analyses of Commercial Feeding Stuffs	J. L. Hills, C. H. Jones, and B. O. White.
Bulletin 92	Analyses of Commercial Fertilizers	Do.
Bulletin 93	Commercial Fertilizers	Do.
Bulletin 94	Vermont Grasses and Clovers	L. R. Jones.
Bulletin 95	A Poisonous Plant	F. A. Rich and L. R. Jones.
Bulletin 96	Apple Pomace a Good Feed for Cows	J. L. Hills.
Bulletin 97	Analyses of Commercial Feeding Stuffs	J. L. Hills, C. H. Jones, and B. O. White.

VIRGINIA STATION.

1900.		
Bulletin 119	The Most Common Irregularities of the Teeth of the Horse, I.	C. McCulloch.
1901.		
Bulletin 120	The Most Common Irregularities of the Teeth of the Horse, II.	Do.
Bulletin 121	Steer Feeding	D. O. Nourse.
Bulletin 122	Comparative Skimming Qualities of Holstein and Jersey Milk.	W. D. Saunders.
Bulletin 123	Preliminary Report on the Use of Blackleg Vaccine in Virginia.	E. P. Niles.
Bulletin 124	Sheep Scab	J. Spencer
Bulletin 125	Mange in Horses	Do.
Bulletin 126	The Stomach Worm	Do.
Bulletin 127	Observations on the Production of Vinegar in Cellars	W. B. Alwood and R. J. Davidson.
Bulletin 128	Orchard Studies	W. B. Alwood.
Annual Report	Annual Report, 1901	

WASHINGTON STATION.

1902.		
Bulletin 50	A Preliminary Report on Glanders	S. B. Nelson.
Bulletin 51	Locating Orchards in Washington	S. W. Fletcher.
Bulletin 52	Planting Orchards in Washington	Do.
Bulletin 53	Nursery Stock for Washington Orchards	Do.

WEST VIRGINIA STATION.

1901.		
Bulletin 77	The New Fertilizer Law	J. H. Stewart.
1902.		
Bulletin 78	Treatment for San José Scale	Do.
Bulletin 79	Commercial Fertilizers	J. H. Stewart and B. H. Hite.
Bulletin 80	Fertilizers. Part I, Sources and Composition	B. H. Hite.

WISCONSIN STATION.

1901.		
Annual Report	Eighteenth Annual Report, 1901	
1902.		
Bulletin 90	Concentrated Feeding Stuffs and Fertilizers Licensed for Sale in Wisconsin, 1902.	F. W. Woll.
Bulletin 91	Oat Smut in Wisconsin—Prevalence and Method of Eradication.	R. A. Moore.

WISCONSIN STATION—Continued.

Publication.	Title.	Author.
1902.		
Bulletin 92	Licensed Fertilizers and Concentrated Feeding Stuffs, 1902.	F. W. Woll and A. Vivian.
Bulletin 93	Development and Distribution of Nitrates in Cultivated Soils.	F. H. King and A. R. Whitson.
Bulletin 94	Curing of Cheddar Cheese, with Especial Reference to Cold Curing.	S. M. Babcock and H. L. Russell.
Bulletin 95	Some Observations on Sheep Breeding from the Experiment Station Flock Records.	W. L. Carlyle and T. F. McConnell.

WYOMING STATION.

1901.		
Bulletin 49	Alkali Lakes and Deposits (Alkali Series, VI)	W. C. Knight and E. E. Slosson.
Annual Report	Eleventh Annual Report, 1901	
1902.		
Bulletin 50	Native Vines in Wyoming Homes	A. Nelson.
Bulletin 51	Sheep Feeding on the Range. Lamb Feeding—Second Trial.	F. E. Emery.
Bulletin 52	Experiments in Evaporation	C. B. Ridgaway.
Bulletin 53	The Measurement of Water for Irrigation	B. T. Fleming.
Bulletin 54	The Shrubs of Wyoming	E. E. Nelson.
Bulletin 55	The Birds of Wyoming	W. C. Knight.
Annual Report	Twelfth Annual Report, 1902	

STATISTICS OF THE AGRICULTURAL EXPERIMENT STATIONS.

TABLE 1.—*General statistics, 1902.*

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1901–2. No.	Publications during fiscal year 1901–2. Pages.	Number of addresses on mailing list.	Principal lines of work.
Alabama (College)	Auburn	C. C. Thach[a]	Feb. —, 1883	Feb. 24, 1888	13	8	6	7	467	9,182	Botany; soils; analyses of fertilizers and food materials; field and pot experiments; horticulture; plant breeding; diseases of plants; feeding experiments; diseases of animals; dairying.
Alabama (Canebrake)	Uniontown	J. M. Richeson	Jan. 1, 1886	Apr. 1, 1888	3	......	1	......	......	300	Soil improvement; field experiments; horticulture; floriculture; diseases of plants; diseases of animals; dairying.
Alabama	Tuskegee	G. W. Carver	Feb. 15, 1897	......	11	7	9	10	80	2,000	Field experiments; horticulture; diseases of plants; animal industry; dairying.
Arizona	Tucson	R. H. Forbes	......	1889	8	5	3	7	228	5,100	Chemistry; botany; field experiments; improvement of ranges; horticulture; including date-palm culture; feeding experiments; irrigation.
Arkansas	Fayetteville	R. L. Bennett	......	1887	6	2	4	5	156	8,000	Chemistry of foods; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; diseases of animals.
California	Berkeley	E. W. Hilgard	1875	Mar. —, 1888	31	......	......	......	......	......	Physics; chemistry and geographical distribution of soils; bacteriology; fertilizers; field crops; horticulture; botany; meteorology; technology of wine and olive oil, including zymology; beet-sugar chemistry; chemistry of foods and feeding stuffs; animal husbandry; entomology; dairying; drainage and irrigation; reclamation of alkali lands; plant introduction.

[a] Acting director.

TABLE 1.—*General statistics, 1902*—Continued.

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1901–2.		Number of addresses on mailing list.	Principal lines of work.
								No.	Pages.		
Colorado	Fort Collins	L. G. Carpenter	1879	Feb. —, 1888	15	10	7	26	249	7,300	Chemistry; field experiments; horticulture; plant breeding; entomology; irrigation.
Connecticut (State)	New Haven	E. H. Jenkins	Oct. 1, 1875	May 18, 1887	16	......	5	7	572	10,500	Chemistry; analysis and inspection of fertilizers, foods, and feeding stuffs; inspection of Babcock test apparatus and nurseries; diseases of plants; forestry; field experiments; entomology.
Connecticut (Storrs)	Storrs	L. A. Clinton [a]		do	14	11	3	2	215	7,000	Food and nutrition of man and animals; bacteriology of dairy products; field experiments; dairying.
Delaware	Newark	A. T. Neale		Feb. 21, 1888	6	6	6	7	347	7,278	Chemistry; bacteriology; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; dairying.
Florida	Lake City	T. H. Taliaferro		1888	13	7	5	2	35	5,000	Chemistry; field experiments; horticulture; feeding experiments; veterinary science; entomology.
Georgia	Experiment	R. J. Redding	Feb. 18, 1888	July 1, 1889	7	1	....	4	282	9,000	Field experiments; horticulture; entomology; pig feeding; dairying.
Idaho	Moscow	H. T. French		Feb. 26, 1892	8	7	6	4	59	3,500	Chemistry; physics; botany; field experiments; horticulture; entomology; feeding experiments.
Illinois	Urbana	E. Davenport		Mar. 21, 1888	22	10	11	10	219	19,500	Chemistry; bacteriology; field experiments; horticulture; forestry; plant breeding; diseases of plants; diseases of animals; feeding experiments; entomology; dairying.
Indiana	Lafayette	H. A. Huston	1885	Jan. —, 1888	10	7	9	6	198	8,456	Chemistry; pot and field experiments; horticulture; feeding experiments; diseases of plants and animals.
Iowa	Ames	C. F. Curtiss		Feb. 17, 1888	21	14	10	5	165	20,000	Chemistry; botany; field experiments; horticulture; diseases of plants; feeding experiments; entomology; dairying.

Kansas	Manhattan	J. T. Willard		Feb. 8, 1888	17	13	15	8	276	23,350	Soils; horticulture; plant breeding; field experiments; feeding and digestion experiments; diseases of animals; entomology; dairying; extermination of prairie dogs and gophers.
Kentucky	Lexington	M. A. Scovell	Sept. —, 1885	Apr. —, 1888	16	......	4	8	305	8,300	Chemistry; soils; analysis of fertilizers, foods, and feeding stuffs; field experiments; horticulture; plant breeding; animal husbandry; diseases of plants; entomology; dairying.
Louisiana (Sugar)	New Orleans	W. C. Stubbs	Sept. —, 1885								Chemistry; bacteriology; soils and soil physics; field experiments; horticulture; sugar making; drainage; irrigation.
Louisiana (State)	Baton Rouge	...do	Apr. —, 1886		26	4	10	6	279	15,000	Chemistry; geology; botany; bacteriology; soils; inspection of fertilizers and Paris green; field experiments; horticulture; animal husbandry; diseases of animals; entomology.
Louisiana (North)	Calhoun	...do	May —, 1887								Chemistry; soils; fertilizers; field experiments; horticulture; feeding experiments; stock raising; dairying.
Maine	Orono	C. D. Woods	Mar. —, 1885	Oct. 1, 1887	12	7	3	11	240	7,000	Chemistry; botany; analysis and inspection of fertilizers, concentrated commercial feeding stuffs, and creamery glassware; horticulture; diseases of plants; seed tests; food and nutrition of man and animals; poultry raising; marine invertebrates; diseases of animals; entomology; dairying.
Maryland	College Park	H. J. Patterson	1888	Apr. —, 1888	15	8	6	9	9	12,500	Chemistry; soils; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology.
Massachusetts	Amherst	H. H. Goodell	[b]1882	Mar. 2, 1888	19	8	6	9	406	1,700	Chemistry; meteorology; analysis and inspection of fertilizers and concentrated commercial feeding stuffs; inspection of creamery glassware and nurseries; field experiments; horticulture; electro-germination; diseases of plants; digestion and feeding experiments; diseases of animals; entomology; dairying.
Michigan	Agricultural College.	C. D. Smith		Feb. 26, 1888	14	8	7	12	218	31,000	Chemistry; bacteriology; soils; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; entomology; stable hygiene.

[a] Acting director. [b] In 1882 the State organized a station here and maintained it until June 18, 1895, when it became a part of the Hatch Station at the same place.

TABLE 1.—*General statistics, 1902*—Continued.

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1901-2.		Number of addresses on mailing list.	Principal lines of work.
								No.	Pages.		
Minnesota	St. Anthony Park, St. Paul.	W. M. Liggett	Mar. 7, 1885	1888	14	11	....	5	290	13,500	Chemistry; soils; field experiments; horticulture; forestry; diseases of plants; food and nutrition of man; plant and animal breeding; feeding experiments; diseases of animals; entomology; dairying.
Mississippi	Agricultural College.	W. L. Hutchinson	....	Jan. 27, 1888	10	5	7	8	208	17,500	Soils; fertilizers; field experiments; horticulture; animal husbandry; diseases of animals; entomology; dairying.
Missouri (State)	Columbia	H. J. Waters	....	Jan. —, 1888	16	7	5	5	132	12,000	Chemistry; field experiments; horticulture; diseases of plants; feeding experiments; animal and plant breeding; diseases of animals; entomology; dairying; irrigation.
Missouri (Fruit)	Mountain Grove	J. T. Stinson	Feb. 1, 1900	....	4	......	3	1	20	3,000	Horticulture.
Montana	Bozeman	S. Fortier	....	July 1, 1893	9	6	7	5	178	1,812	Chemistry; meteorology; botany; field experiments; horticulture; feeding experiments; poultry experiments; entomology; irrigation.
Nebraska	Lincoln	E. A. Burnett	Dec. 16, 1884	June 13, 1887	17	9	8	5	159	16,000	Chemistry; botany; meteorology; soils; field experiments; horticulture; diseases of plants; forestry; feeding and breeding experiments; diseases of animals; entomology; irrigation.
Nevada	Reno	J. E. Stubbs	....	....	10	6	6	3	180	2,000	Chemistry; botany; soils; field experiments; horticulture; forestry; animal diseases; entomology; irrigation.
New Hampshire	Durham	F. W. Morse [c]	1886	Aug. 4, 1887	11	8	6	13	184	12,000	Chemistry; bacteriology; soil physics; draft and efficiency test of surface-working implements; field experiments; horticulture; diseases of plants; feeding experiments; entomology.

[c] Vice-director.

New Jersey (State)	New Brunswick	E. B. Voorhees	Mar. 10, 1880		12	2	4	5	497	10,000	Chemistry; biology; botany; analysis of fertilizers, foods, and commercial feeding stuffs; pot and field experiments; horticulture; diseases of plants; food and nutrition of man; diseases of animals; entomology; dairy husbandry; soil bacteriology; irrigation.
New Jersey (College)	do	do		Apr. 26, 1888	7	4	3	5	406		
New Mexico	Mesilla Park	Luther Foster		Dec. 14, 1889	11	7		5	166	3,200	Chemistry; botany; field experiments; horticulture; soils; feeding experiments; entomology; irrigation.
New York (State)	Geneva	W. H. Jordan	Mar. —, 1882		24		10	18	996	41,430	Chemistry; bacteriology; meteorology; fertilizers; analysis and control of fertilizers; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; poultry experiments; entomology; dairying; irrigation.
New York (Cornell)	Ithaca	I. P. Roberts	1879	Apr. —, 1888	18	15	6	9	238	19,000	Chemistry of soils, feeding stuffs, and dairy products; soils; fertilizers; field experiments; horticulture; diseases of plants; feeding experiments; diseases of animals; poultry experiments; entomology; dairying.
North Carolina	Raleigh	B. W. Kilgore	Mar. 12, 1877	Mar. 7, 1887	12	6	6	2	140	25,000	Chemistry; soils; field experiments; horticulture; plant diseases; animal husbandry; diseases of animals; poultry experiments; dairying.
North Dakota	Agricultural College.	J. H. Worst		Mar. —, 1890	7	10	6	5	309	9,500	Field experiments; plant breeding; horticulture; diseases of plants; food analysis; feeding experiments; diseases of animals; dairying.
Ohio	Wooster	C. E. Thorne	Apr. 25, 1882	Apr. 2, 1888	15		4	8	195	43,000	Soils; field experiments; horticulture; plant breeding; diseases of plants; breeding and feeding experiments; diseases of animals; entomology.
Oklahoma	Stillwater	John Fields		Dec. 25, 1890	9	6	5	5	228	18,315	Chemistry; field experiments; horticulture; forestry; botany; diseases of plants; animal husbandry; diseases animals; entomology.
Oregon	Corvallis	J. Withycombe		July —, 1888	11	7	4	5	208	4,300	Chemistry; bacteriology; soils; field crops; horticulture; diseases of plants; feeding experiments, entomology; dairying.
Pennsylvania	State College	H. P. Armsby		June 30, 1887	14	7	5	5	466	15,000	Chemistry; meteorology; analysis of fertilizers, foods, and feeding stuffs; horticulture; field experiments; feeding experiments; dairying.
Rhode Island	Kingston	H. J. Wheeler		July 30, 1888	11	3		8	203	6,604	Chemistry; meteorology; soils; analysis and inspection of fertilizers and feeding stuffs; field and pot experiments; horticulture; poultry experiments.

TABLE 1.—*General statistics, 1902*—Continued.

Station.	Location.	Director.	Date of original organization.	Date of organization under Hatch Act.	Number on staff.	Number of teachers on staff.	Number of persons on staff who assist in farmers' institutes.	Publications during fiscal year 1901–2. No.	Publications during fiscal year 1901–2. Pages.	Number of addresses on mailing list.	Principal lines of work.
South Carolina	Clemson College	P. H. Mell		Jan. —, 1888	17	12	11	9	212	9,000	Chemistry; analysis and control of fertilizers; field experiments; horticulture; plant breeding; diseases of plants; feeding experiments; veterinary science; entomology; dairying.
South Dakota	Brookings	J. W. Wilson		Mar. 13, 1887	12	6		4	132	9,000	Soils; field experiments; plant breeding; diseases of plants and animals; animal husbandry; dairying; irrigation.
Tennessee	Knoxville	A. M. Soule	June 8, 1882	Aug. 4, 1887	11	9	5	8	310	10,000	Chemistry; soils; fertilizers; field experiments; horticulture; seeds; weeds; diseases of plants; feeding experiments; entomology; dairying.
Texas	College Station	W. D. Gibbs			14	5	3	5	197	10,000	Chemistry; meteorology; soils; field experiments; horticulture; feeding experiments; diseases of animals; irrigation.
Utah	Logan	J. A. Widtsoe		1890	15	9	7	6	222	6,000	Chemistry of soils and feeding stuffs; alkali soil investigations; meteorology; field experiments; horticulture; diseases of plants; cattle and sheep breeding; feeding experiments; dairying; poultry experiments; irrigation; arid farming.
Vermont	Burlington	J. L. Hills	Nov. 24, 1886	Feb. 28, 1888	11	6	3	9	415	11,350	Chemistry; botany; analysis and control of fertilizers and feeding stuffs; inspection of creamery glassware; field experiments; horticulture; diseases of plants; feeding experiments; dairying.
Virginia	Blacksburg	J. M. McBryde	1888	1891	11	6	4	17	242	9,000	Field crops; horticulture; bacteriology; feeding experiments; veterinary science; entomology; cider and vinegar making; ferments.

Washington	Pullman	E. A. Bryan		1891	14	8	9	7	118	5,000	Chemistry; botany; bacteriology; soils; field experiments; horticulture; plant breeding; diseases of plants; feeding and breeding experiments; oyster culture; diseases of animals; entomology; dairying; irrigation.
West Virginia	Morgantown	J. H. Stewart		June 11, 1888	15	5	7	7	290	8,000	Chemistry; analysis and control of fertilizers; soils; field experiments; horticulture; inspection of orchards and nurseries; feeding experiments; poultry experiments; entomology.
Wisconsin	Madison	W. A. Henry	1883	1887	17	14	8	7	449	13,000	Chemistry; bacteriology; soils; field experiments; horticulture; feeding experiments; dairying; drainage and irrigation.
Wyoming	Laramie	B. C. Buffum	1887	Mar. 1, 1891	8	8		5	204	3,700	Geology; botany; meteorology; waters soils; range improvement; fertilizers; field experiments; food analysis; feeding experiments; entomology; irrigation.
Total					710	364	288	373	13,409	596,277	

TABLE 2.—*Revenue and additions to equipment in 1902.*

Station.	Hatch fund.	State.	Individuals and communities.	Fees.	Farm products.	Miscellaneous.	Total.	Additions to equipment in 1902.						
								Buildings.	Library.	Apparatus.	Farm implements.	Live stock.	Miscellaneous.	Total.
Alabama (College)	$15,000.00			$5,201.66	$736.59		$20,938.25	$475.14	$506.74	$302.76	$145.60	$193.75	$247.00	$1,870.99
Alabama (Canebrake)		$2,500.00					2,500.00	2,500.00	250.00		100.00	200.00	100.00	3,150.00
Alabama (Tuskegee)		1,500.00					1,500.00		100.00	40.00	25.00	80.00	75.00	320.00
Arizona	15,000.00	940.36		5.00	879.10	$108.60	16,933.06	700.00	50.00	60.00	330.00	730.00	290.00	2,160.00
Arkansas	15,000.00				1,230.57		16,230.57	162.31	80.08	58.65	570.00	23.95		894.99
California	15 000.00	11,923.00			549.22		27,472.22	83.00	44.13	42.90				170.03
Colorado	15,000.00				1,036.26	a 1,989.83	18,026.09	600.00	117.87	530.00	105.00			1,352.87
Connecticut (State)	7,500.00	15,500.00	$2,301.38	5,322.85	1,241.00	52.46	31,917.69		593.74	106.45			292.90	993.09
Connecticut (Storrs)	7,500.00	1,800.00			119.21		9,419.21	308.58		520.33	9.00	12.15		850.06
Delaware	15,000.00						15,000.00	267.04	518.38	366.93	58.80		1,491.62	2,702.77
Florida	15,000.00				1,271.71		16,271.71	300.00	137.93	17.75	176.00	397.93		1,029.61
Georgia	15,000.00	740.25			2,263.26	b 2,498.49	20,502.00		25.00		100.00	50.00		175.00
Idaho	15,000.00	1,000.00			965.75		16,965.75		125.00	120.00	175.75			420.75
Illinois	15,000.00	54,000.00		600.00	246.92	b 865.24	70,712.16	108.53	127.69	345.35	136.87	495.00	461.19	1,674.63
Indiana	15,000.00				a 3,306.48		18,306.48	42.26	108.75	16.20	187.67	145.00		499.88
Iowa	15,000.00			6.00	4,304.61	27.51	19,338.12	43.97	10.00	562.26	490.83	99.00		1,206.06
Kansas	15,000.00				1,351.68	b 800.96	17,152.64	3,000.60	76.85	3,772.57	336.50	37.00	7,260.96	14,484.48
Kentucky	15,000.00	a 4,683.62		a 26,393.58	a 6,501.02	a 331.51	52,909.73	1,296.96	919.45	245.21	399.51	2,101.00	609.90	5,572.03
Louisiana	15,000.00	17,000.00		8,000.00	1,866.05	a 8,341.14	50,207.19	659.07	17.96	65.98	337.20	579.21	1,704.14	3,363.56
Maine	15,000.00			c 4,213.25	3,078.66	b 73.89	22,365.80		218.09	100.00	100.00			418.09
Maryland	15,000.00				4,808.89	b 723.34	20,532.23	1,493.11	358.93	97.40	1,005.80	64.93		3,020.17
Massachusetts	15,000.00	11,200.00		3,405.00	2,274.66	2,319.66	34,199.32		284.40	703.21	538.16	664.02		2,189.79
Michigan	15,000.00	5,000.00		1,860.00	2,736.08	a 1,976.14	26,572.22	1,944.19	202.22	823.51	243.30			3,213.22
Minnesota	15,000.00	d 42,130.01			d 13,579.11		70,709.12	28,000.00	1,000.00	552.70	847.40	3,585.25		33,985.35
Mississippi	15,000.00				1,112.32	a 277.37	16,389.69	45.00	132.00		485.00	300.00	50.00	1,012.00
Missouri (State)	15,000.00			2,087.69	3,460.85	a 3,842.89	24,391.43	75,000.00	150.00	150.00	75.00	1,400.00		76,775.00
Missouri (Fruit)		e 26,525.00					26,525.00	2,000.00	225.00	825.00	420.00	180.00	300.00	3,950.00
Montana	15,000.00	825.09			4,183.61		20,008.70	417.45	50.00	186.36	185.05	500.00	269.30	1,608.16
Nebraska	15,000.00				4,613.18	b 983.56	20,596.74	823.46	151.03	681.80	309.55	1,205.00	2,139.69	5,310.53
Nevada	15,000.00				598.49	b 432.57	16,031.06	621.23	49.68	58.38	248.80		555.70	1,533.79
New Hampshire	15,000.00			592.50			15,592.50		253.86	286.73	129.11		351.65	1,021.35
New Jersey (State)		20,000.00							91.24	965.31			727.18	1,783.73
New Jersey (College)	15,000.00						15,000.00		620.13	204.22	104.00		88.67	1,017.02
New Mexico	15,000.00				1,115.42		16,115.42	1,064.57	156.56	4.59	1,270.68	377.25	504.04	3,377.69
New York (State)	1,500.00	74,847.55				f 5,558.97	81,906.52		600.00	36.69		176.00		812.69
New York (Cornell)	13,500.00	g 12,666.67			a 583.21	a 538.56	27,288.44	2,150.00	150.00	188.57	178.00			2,666.57
North Carolina	15,000.00	g 5,000.00			199.73		20,199.73		12.97	49.00	211.98	1,580.45		1,854.40
North Dakota	15,000.00				1,959.85	966.25	17,926.10		19.00	417.89	478.67	350.00		1,265.56
Ohio	15,000.00	21,900.00		324.80	a 9,632.59	a 12,591.31	59,448.70	1,175.65	153.98	14.07	129.76		78.96	1,552.42
Oklahoma	15,000.00				2,500.00	b 838.93	18,338.93	1,194.40	14.70	32.76	376.31		276.89	1,895.06
Oregon	15,000.00				a 1,973.73		16,973.73	602.15	70.46	98.12	139.54	538.06		1,448.33

Pennsylvania	15,000.00	....	....	10,201.00	3,324.61	663.89	29,189.50	....	670.21	2,176.48	165.75	71.00	688.18	3,771.62
Rhode Island	15,000.00	....	....	....	1,052.01	a 278.79	16,330.80	2,363.71	518.31	175.39	378.30	....	....	3,435.71
South Carolina	15,000.00	....	....	....	1,030.39	....	16,030.39	210.82	189.03	292.18	192.05	804.52	....	1,688.60
South Dakota	15,000.00	1,000.00	....	....	437.01	213.58	16,650.59	678.19	....	509.18	214.45	....	254.37	1,656.19
Tennessee	15,000.00	....	....	....	3,074.28	h 734.92	18,809.20	473.19	267.96	141.78	254.45	500.00	25.00	1,662.38
Texas	15,000.00	15,000.00	....	....	....	a 659.22	30,659.22	309.65	76.62	371.41	13.74	22.00	100.87	894.29
Utah	15,000.00	....	....	....	1,819.67	a 712.01	17,531.68	12,000	67.82	262.25	276.70	400.00	54.43	13,061.20
Vermont	15,000.00	1,000.00	....	3,483.53	7,032.76	....	26,516.29	1,482.49	137.13	330.32	371.41	424.00		2,745.35
Virginia	15,000.00	....	....	....	....	20.81	15,020.81	....	....	209.18	....	....	....	209.18
Washington	15,000.00	6,089.57	....	....	....	i 645.51	21,735.08	22,000.00	6.00	216.35	54.34	379.12	289.70	22,945.51
West Virginia	15,000.00	....	....	8,045.50	436.64	120.00	23,602.14	2,467.06	256.08	345.17	42.55	544.21	....	3,655.07
Wisconsin	15,000.00	g 15,000.00	....	1,200.00	....	....	31,200.00	6,000.00	479.00	447.00	1,342.00	483.00	....	8,751.00
Wyoming	15,000.00	....	....	....	1,157.42	....	16,157.42	1,050.00	500.00	601.60	516.98	861.47	221.75	3,751.80
Total	720,000.00	369,771.12	2,301,38	80,942.36	105,644.60	50,187.91	1,328,847.37	176,113.78	11,941.98	19,727.94	14,982.56	20,554.27	19,509.09	262,829.62

a Including balance.
b Balance from previous year.
c For calendar year 1901.
d Including substations.
e For biennial period 1901 and 1902.
f Insurance.
g Estimated amount of State appropriation spent for experimental purposes.
h Dairy and live stock.
i Including fees and farm products.

TABLE 3.—*Expenditures from United States appropriation for year ended June 30, 1902.*[a]

Station.	Amount.	Itemized.																	
		Salaries.	Labor.	Publications.	Postage and stationery.	Freight and express.	Heat, light, and water.	Chemical supplies.	Seeds, plants, and sundry supplies.	Fertilizers.	Feeding stuffs.	Library.	Tools, implements, and machinery.	Furniture and fixtures.	Scientific apparatus.	Live stock.	Traveling expenses.	Contingent expenses.	Building and repairs.
Alabama	$15,000.00	$8,640.00	$1,445.37	$1,146.90	......	$317.11	$329.61	$451.88	$830.17	$267.14	$322.41	$506.74	$392.14	$17.72	$302.76	$15.05	......	$15.00	......
Arizona	15,000.00	7,514.58	3,631.87	1,181.92	$257.60	334.24	124.36	235.97	167.63	257.62	169.83	43.38	332.41	289.38	63.99	25.25	$197.86	100.00	$72.11
Arkansas	15,000.00	8,305.25	2,097.50	920.13	335.78	405.28	14.24	235.52	621.49	4.40	670.76	80.08	570.00	......	58.65	23.95	384.66	110.00	162.31
California	15,000.00	6,989.92	4,371.29	418.34	310.87	104.51	135.58	762.31	618.61	......	319.20	48.83	55.91	89.00	42.90	......	644.73	5.00	83.00
Colorado	15,000.00	10,537.81	396.70	1,275.18	145.53	147.86	......	15.55	53.04	59.50	......	96.18	104.79	88.65	494.47	256.00	1,278.77	40.00	9.97
Connecticut (State)	7,500.00	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Connecticut (Storrs)	7,500.00	4,407.35	935.95	6.00	329.86	64.25	354.37	140.90	228.18	38.26	10.07	......	27.06	103.14	426.92	12.15	91.96	15.00	308.58
Delaware	15,000.00	9,210.00	978.17	1,154.59	193.00	101.18	351.80	94.82	496.52	......	54.98	518.38	58.80	337.03	366.93	......	700.70	116.06	267.04
Florida	15,000.00	6,061.05	3,714.68	1,069.55	344.62	182.60	322.60	37.78	438.30	304.08	1,254.39	126.68	170.75	......	8.07	397.93	251.92	15.00	300.00
Georgia	15,000.00	7,787.65	2,391.70	986.08	221.19	202.96	226.43	300.00	566.71	199.83	583.38	86.76	299.84	57.41	180.52	......	125.34	34.20	750.00
Idaho	15,000.00	8,166.62	3,051.95	411.53	57.85	138.75	967.34	299.07	199.53	1.15	66.22	44.22	175.75	87.49	120.00	......	351.05	125.05	736.43
Illinois	15,000.00	6,498.36	2,349.26	1,317.09	776.55	242.02	321.16	514.07	337.93	5.75	493.00	127.69	136.87	461.19	345.35	495.00	351.67	118.51	108.53
Indiana	15,000.00	8,601.19	2,396.19	689.20	77.57	155.74	504.31	12.97	647.74	7.25	817.29	108.75	304.85	32.65	16.20	174.08	117.76	28.05	308.21
Iowa	15,000.00	7,168.37	3,189.96	843.92	620.50	399.75	225.50	66.35	666.68	19.54	202.78	10.00	490.83	3.50	562.26	99.00	372.09	15.00	43.97
Kansas	15,000.00	7,870.03	3,142.62	635.89	221.79	198.87	87.85	112.48	305.66	6.00	794.19	78.53	110.85	207.27	218.47	550.26	258.59	33.70	166.95
Kentucky	15,000.00	11,440.00	1,187.62	122.80	179.45	95.41	26.82	341.74	144.23	......	......	919.45	71.95	106.25	199.21	......	14.48	85.84	64.75
Louisiana	15,000.00	8,087.37	3,221.53	609.40	170.76	247.23	239.35	275.00	422.50	158.09	747.06	17.96	275.89	......	53.97	473.89	......	......	......
Maine	15,000.00	7,882.52	1,788.15	245.00	243.65	229.75	953.09	330.20	409.49	157.17	1,000.33	218.09	116.63	113.26	103.64	248.50	259.62	15.00	685.91
Maryland	15,000.00	8,025.64	2,690.52	671.85	105.30	100.00	341.70	206.89	468.03	100.83	241.68	358.93	505.80	191.08	97.40	64.93	64.42	15.00	750.00
Massachusetts	15,000.00	7,366.88	2,224.12	1,205.64	359.37	60.57	765.27	......	530.60	444.25	210.83	140.53	538.16	28.95	59.24	410.93	150.57	131.15	372.94
Michigan	15,000.00	7,264.12	2,471.05	297.47	286.75	198.10	......	206.67	1,017.24	......	594.68	199.56	198.79	27.50	770.63	1,120.32	125.92	......	221.20
Minnesota	15,000.00	10,306.55	1,350.00	382.50	......	......	650.00	19.15	48.70	......	1,456.70	......	3.25	......	......	776.00	......	......	7.15
Mississippi	15,000.00	7,882.74	1,510.27	835.02	214.48	334.20	175.92	374.00	643.31	58.05	1,163.56	80.80	665.66	......	79.75	208.28	325.44	15.00	433.52
Missouri	15,000.00	6,403.19	2,158.02	248.29	101.93	599.68	188.02	130.88	366.84	1.50	2,515.13	145.25	97.42	32.30	150.16	1,378.60	299.64	15.00	168.15
Montana	15,000.00	9,018.25	2,215.06	1,232.88	182.68	438.17	281.72	135.56	470.12	32.50	105.54	223.81	185.05	269.30	186.36	......	......	23.00	......
Nebraska	15,000.00	8,259.83	1,498.65	1,010.79	764.87	171.18	......	283.20	764.06	......	1,004.66	151.03	66.00	245.93	257.17	105.00	50.05	......	367.58
Nevada	15,000.00	9,759.50	3,050.08	32.07	83.74	72.51	495.95	36.33	439.89	......	......	......	6.50	4.00	11.55	......	246.65	140.00	621.23
New Hampshire	15,000.00	9,010.39	1,825.13	1,329.35	95.21	92.00	583.37	102.49	378.59	186.90	7.00	253.86	153.93	351.65	286.73	......	293.79	20.60	29.01
New Jersey	15,000.00	9,580.00	953.51	1,506.93	268.68	82.61	279.15	56.37	160.90	156.41	154.62	620.13	104.00	228.94	204.22	......	383.66	171.20	88.67
New Mexico	15,000.00	6,821.05	2,691.65	245.56	504.41	771.36	97.54	2.80	711.20	111.00	259.32	156.56	1,317.53	505.04	4.59	377.25	388.14	35.00	......
New York (State)	1,500.00	......	......	1,187.75	33.10	......	......	19.60	......	......	......	2.00	......	75.00	......	......	37.66	144.89	......
New York (Cornell)	13,500.00	8,681.10	1,803.66	1,690.24	309.95	94.09	88.47	30.28	399.42	17.27	4.00	78.87	19.50	1.50	147.23	......	64.43	30.00	39.99
North Carolina	15,000.00	8,203.77	1,585.45	80.82	117.60	250.30	9.03	62.16	190.42	90.42	568.27	12.97	270.08	20.50	49.00	2,890.87	58.55	210.00	329.79
North Dakota	15,000.00	7,211.27	3,328.01	914.40	65.00	......	577.38	97.92	592.08	......	789.83	19.00	490.22	......	417.89	350.00	124.00	23.00	......
Ohio	15,000.00	12,102.63	585.92	......	179.12	15.62	312.06	......	646.06	175.45	379.83	52.55	388.47	79.22	......	......	......	15.00	68.07
Oklahoma	15,000.00	5,827.00	2,957.65	1,442.19	669.21	213.14	414.64	218.84	197.03	102.80	581.85	14.70	376.31	276.89	32.76	555.67	354.32	15.00	750.00
Oregon	15,000.00	10,463.50	2,114.52	469.85	71.23	131.75	......	247.86	133.59	15.13	423.00	70.46	139.54	......	98.12	......	......	19.30	602.15

Pennsylvania	15,000.00	10,978.76	6.50	24.20	225.82	....	149.01	875.46	64.84	176.03	951.50	327.25	33.64	4.25	218.57	398.14	242.25	25.00	298.78
Rhode Island	15,000.00	6,947.87	3,108.13	2.50	294.28	141.97	988.09	13.04	462.20	183.73	619.06	518.31	378.30	212.35	175.39	....	177.36	29.40	748.02
South Carolina	15,000.00	7,550.58	2,330.41	1,146.63	189.94	304.51	38.89	374.81	385.00	265.62	375.88	189.03	192.05	24.90	292.18	804.52	302.98	21.25	210.82
South Dakota	15,000.00	8,966.64	1,312.49	1,148.46	277.21	276.28	1.35	269.18	450.89	....	218.53	....	339.45	254.37	386.00	87.18	317.79	15.00	679.18
Tennessee	15,000.00	7,646.67	3,908.27	897.19	293.48	39.05	287.10	101.80	246.28	80.60	378.08	267.96	254.45	....	141.78	....	148.83	158.15	150.31
Texas	15,000.00	8,908.55	1,544.37	1,341.66	572.19	237.12	30.50	426.96	340.53	36.47	158.45	76.62	34.01	100.87	371.41	22.00	364.03	51.75	382.51
Utah	15,000.00	8,451.78	3,487.32	481.71	280.48	62.19	206.20	241.55	212.87	....	341.08	67.82	276.70	54.43	60.70	269.00	59.95	31.25	414.97
Vermont	15,000.00	6,616.35	2,806.68	1,124.86	397.56	158.58	481.31	202.92	131.91	36.60	1,252.71	137.13	34.68	132.41	330.32	27.00	312.53	66.45	750.00
Virginia	15,000.00	9,048.64	2,101.99	1,654.62	56.88	118.09	239.33	143.29	638.87	52.40	405.56	....	....	....	209.18	....	81.00	15.00	235.15
Washington	15,000.00	8,426.37	2,738.97	277.15	102.31	141.76	883.50	26.45	588.05	....	144.02	6.00	54.34	85.75	216.35	162.75	421.40	10.00	714.83
West Virginia	15,000.00	11,306.38	225.90	7.80	189.33	432.35	556.55	551.35	377.84	81.00	161.76	250.88	1.50	....	345.17	39.00	276.64	15.00	181.05
Wisconsin	15,000.00	8,908.33	2,368.16	....	115.05	85.73	35.00	654.97	1,118.15	9.83	243.70	452.05	125.00	....	166.73	360.00	312.75	2.00	42.55
Wyoming............	15,000.00	4,350.17	3,731.94	1,109.86	573.25	466.90	624.41	221.75	276.56	7.50	332.16	34.85	516.98	388.95	212.65	861.47	648.81	27.00	614.79

[a] The expenditures under the different heads are affected by the total revenue of the station, as shown in Table 2.

FEDERAL LEGISLATION, REGULATIONS, AND RULINGS AFFECTING AGRICULTURAL COLLEGES AND EXPERIMENT STATIONS.

FEDERAL LEGISLATION.

ACT OF 1862 DONATING LANDS FOR AGRICULTURAL COLLEGES.

AN ACT donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there be granted to the several States, for the purposes hereinafter mentioned, an amount of public land, to be apportioned to each State a quantity equal to thirty thousand acres for each Senator and Representative in Congress to which the States are respectively entitled by the apportionment under the census of eighteen hundred and sixty: *Provided*, That no mineral lands shall be selected or purchased under the provisions of this act.

SEC. 2. That the land aforesaid, after being surveyed, shall be apportioned to the several States in sections or subdivisions of sections, not less than one quarter of a section; and whenever there are public lands in a State subject to sale at private entry at one dollar and twenty-five cents per acre, the quantity to which said State shall be entitled shall be selected from such lands within the limits of such State, and the Secretary of the Interior is hereby directed to issue to each of the States in which there is not the quantity of public lands subject to sale at private entry at one dollar and twenty-five cents per acre to which said State may be entitled under the provisions of this act land scrip to the amount in acres for the deficiency of its distributive share; said scrip to be sold by said States and the proceeds thereof applied to the uses and purposes prescribed in this act and for no other use or purpose whatsoever: *Provided*, That in no case shall any State to which land scrip may thus be issued be allowed to locate the same within the limits of any other State or of any Territory of the United States, but their assignees may thus locate said land scrip upon any of the unappropriated lands of the United States subject to sale at private entry at one dollar and twenty-five cents, or less, per acre: *And provided further*, That not more than one million acres shall be located by such assignees in any one of the States: *And provided further*, That no such location shall be made before one year from the passage of this act.

SEC. 3. That all the expenses of management, superintendence, and taxes from date of selection of said lands, previous to their sales, and all expenses incurred in the management and disbursement of the moneys which may be received therefrom, shall be paid by the States to which they may belong, out of the treasury of said States, so that the entire proceeds of the sale of said lands shall be applied without any diminution whatever to the purposes hereinafter mentioned.

SEC. 4. That all moneys derived from the sale of the lands aforesaid by the States to which the lands are apportioned, and from the sales of land scrip hereinbefore provided for, shall be invested in stocks of the United States, or of the States, or some other safe stocks, yielding not less than five per centum upon the par value of said stocks; and that the moneys so invested shall constitute a perpetual fund, the capital of which shall remain forever undiminished (except so far as may be provided in section fifth of this act), and the interest of which shall be inviolably appropriated, by each State which may take and claim the benefit of this act, to the endowment, support, and maintenance of at least one college where the leading object shall

be, without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and the mechanic arts, in such manner as the legislatures of the States may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions in life.

SEC. 5. That the grant of land and land scrip hereby authorized shall be made on the following conditions, to which, as well as to the provisions hereinbefore contained, the previous assent of the several States shall be signified by legislative acts:

First. If any portion of the fund invested, as provided by the foregoing section, or any portion of the interest thereon, shall, by any action or contingency, be diminished or lost, it shall be replaced by the State to which it belongs, so that the capital of the fund shall remain forever undiminished; and the annual interest shall be regularly applied without diminution to the purposes mentioned in the fourth section of this act, except that a sum, not exceeding ten per centum upon the amount received by any State under the provisions of this act, may be expended for the purchase of lands for sites or experimental farms, whenever authorized by the respective legislatures of said States.

Second. No portion of said fund, nor the interest thereon, shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings.

Third. Any State which may take and claim the benefit of the provisions of this act shall provide, within five years, at least not less than one college, as described in the fourth section of this act, or the grant to such State shall cease; and said State shall be bound to pay the United States the amount received of any lands previously sold and that the title to purchasers under the State shall be valid.

Fourth. An annual report shall be made regarding the progress of each college, recording any improvements and experiments made, with their cost and results and such other matters, including State industrial and economical statistics, as may be supposed useful, one copy of which shall be transmitted by mail free, by each, to all the other colleges which may be endowed under the provisions of this act, and also one copy to the Secretary of the Interior.

Fifth. When lands shall be selected from those which have been raised to double the minimum price, in consequence of railroad grants, they shall be computed to the State at the maximum price and the number of acres proportionately diminished.

Sixth. No State while in a condition of rebellion or insurrection against the Government of the United States shall be entitled to the benefit of this act.

Seventh. No State shall be entitled to the benefits of this act unless it shall express its acceptance thereof by its legislature within two years from the date of its approval by the President.

SEC. 6. That land scrip issued under the provisions of this act shall not be subject to location until after the first day of January, one thousand eight hundred and sixty-three.

SEC. 7. That the land officers shall receive the same fees for locating land scrip issued under the provisions of this act as is now allowed for the location of military bounty land warrants under existing laws: *Provided*, Their maximum compensation shall not be thereby increased.

SEC. 8. That the governors of the several States to which scrip shall be issued under this act shall be required to report annually to Congress all sales made of such scrip until the whole shall be disposed of, the amount received for the same, and what appropriation has been made of the proceeds.

Approved, July 2, 1862.

Act of 1866 Extending the Time Within Which Agricultural Colleges May be Established.

AN ACT to amend the fifth section of an act entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," approved July 2, 1862, so as to extend the time within which the provisions of said act shall be accepted and such colleges established.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the time in which the several States may comply with the provisions of the act of July two, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," is hereby extended so that the acceptance of the benefits of the said act may be expressed within three years from the passage of this act, and the colleges required by the said act may be provided within five years from the date of the filing of such acceptance with the Commissioner of the General Land Office: *Provided,* That when any Territory shall become a State and be admitted into the Union, such new State shall be entitled to the benefits of the said act of July two, eighteen hundred and sixty-two, by expressing the acceptance therein required within three years from the date of its admission into the Union, and providing the college or colleges within five years after such acceptance, as prescribed in this act: *Provided further,* That any State which has heretofore expressed its acceptance of the act herein referred to shall have the period of five years within which to provide at least one college, as described in the fourth section of said act, after the time for providing said college, according to the act of July second, eighteen hundred and sixty-two, shall have expired.

Approved, July 23, 1866.

Act of 1887 Establishing Agricultural Experiment Stations.

AN ACT to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and the acts supplementary thereto.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That in order to aid in acquiring and diffusing among the people of the United States useful and practical information on subjects connected with agriculture, and to promote scientific investigation and experiment respecting the principles and applications of agricultural science, there shall be established, under direction of the college or colleges or agricultural department of colleges in each State or Territory established, or which may hereafter be established, in accordance with the provisions of an act approved July second, eighteen hundred and sixty-two, entitled "An act donating public lands to the several States and Territories which may provide colleges for the benefit of agriculture and the mechanic arts," or any of the supplements to said act, a department to be known and designated as an "agricultural experiment station:" *Provided,* That in any State or Territory in which two such colleges have been or may be so established the appropriation hereinafter made to such State or Territory shall be equally divided between such colleges, unless the legislature of such State or Territory shall otherwise direct.

Sec. 2. That it shall be the object and duty of said experiment stations to conduct original researches or verify experiments on the physiology of plants and animals; the diseases to which they are severally subject, with the remedies of the same; the chemical composition of useful plants at their different stages of growth; the comparative advantages of rotative cropping as pursued under the varying series of crops; the capacity of new plants or trees for acclimation; the analysis of soils and water; the chemical composition of manures, natural or artificial, with experiments designed to test their comparative effects on crops of different kinds; the adaptation and

value of grasses and forage plants; the composition and digestibility of the different kinds of food for domestic animals; the scientific and economic questions involved in the production of butter and cheese; and such other researches or experiments bearing directly on the agricultural industry of the United States as may in each case be deemed advisable, having due regard to the varying conditions and needs of the respective States and Territories.

SEC. 3. That in order to secure, as far as practicable, uniformity of methods and results in the work of said stations, it shall be the duty of the United States Commissioner [now Secretary] of Agriculture to furnish forms, as far as practicable, for the tabulation of results of investigation or experiments; to indicate from time to time such lines of inquiry as to him shall seem most important; and, in general, to furnish such advice and assistance as will best promote the purpose of this act. It shall be the duty of each of said stations annually, on or before the first day of February, to make to the governor of the State or Territory in which it is located a full and detailed report of its operations, including a statement of receipts and expenditures, a copy of which report shall be sent to each of said stations, to the said Commissioner [now Secretary] of Agriculture, and to the Secretary of the Treasury of the United States.

SEC. 4. That bulletins or reports of progress shall be published at said stations at least once in three months, one copy of which shall be sent to each newspaper in the States or Territories in which they are respectively located, and to such individuals actually engaged in farming as may request the same and as far as the means of the station will permit. Such bulletins or reports and the annual reports of said stations shall be transmitted in the mails of the United States free of charge for postage, under such regulations as the Postmaster-General may from time to time prescribe.

SEC. 5. That for the purpose of paying the necessary expenses of conducting investigations and experiments and printing and distributing the results as hereinbefore prescribed, the sum of fifteen thousand dollars per annum is hereby appropriated to each State, to be specially provided for by Congress in the appropriations from year to year, and to each Territory entitled under the provisions of section eight of this act, out of any money in the Treasury proceeding from the sales of public lands, to be paid in equal quarterly payments on the first day of January, April, July, and October in each year, to the treasurer or other officer duly appointed by the governing boards of said colleges to receive the same, the first payment to be made on the first day of October, eighteen hundred and eighty-seven: *Provided, however*, That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such station; and thereafter an amount not exceeding five per centum of such annual appropriation may be so expended.

SEC. 6. That whenever it shall appear to the Secretary of the Treasury from the annual statement of receipts and expenditures of any of said stations that a portion of the preceding annual appropriation remains unexpended, such amount shall be deducted from the next succeeding annual appropriation to such station, in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support.

SEC. 7. That nothing in this act shall be construed to impair or modify the legal relation existing between any of the said colleges and the government of the States or Territories in which they are respectively located.

SEC. 8. That in States having colleges entitled under this section to the benefits of this act and having also agricultural experiment stations established by law separate from said colleges, such State shall be authorized to apply such benefits to experiments at stations so established by such States; and in case any State shall have established under the provisions of said act of July second, aforesaid, an agricultural department or experimental station, in connection with any university, college, or

institution not distinctly an agricultural college or school, and such State shall have established or shall hereafter establish a separate agricultural college or school, which shall have connected therewith an experimental farm or station, the legislature of such State may apply in whole or in part the appropriation by this act made to such separate agricultural college or school, and no legislature shall by contract, express or implied, disable itself from so doing.

SEC. 9. That the grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purposes of said grants: *Provided*, That payment of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of its legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof duly certified to the Secretary of the Treasury.

SEC. 10. Nothing in this act shall be held or construed as binding the United States to continue any payments from the Treasury to any or all the States or institutions mentioned in this act, but Congress may at any time amend, suspend, or repeal any or all the provisions of this act.

Approved, March 2, 1887.

ACT OF 1890 FOR THE FURTHER ENDOWMENT OF AGRICULTURAL COLLEGES.

AN ACT to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts established under the provisions of an act of Congress approved July second, eighteen hundred and sixty-two.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there shall be, and hereby is, annually appropriated, out of any money in the Treasury not otherwise appropriated, arising from the sales of public lands, to be paid as hereinafter provided, to each State and Territory for the more complete endowment and maintenance of colleges for the benefit of agriculture and the mechanic arts now established, or which may be hereafter established, in accordance with an act of Congress approved July second, eighteen hundred and sixty-two, the sum of fifteen thousand dollars for the year ending June thirtieth, eighteen hundred and ninety, and an annual increase of the amount of such appropriation thereafter for ten years by an additional sum of one thousand dollars over the preceding year, and the annual amount to be paid thereafter to each State and Territory shall be twenty-five thousand dollars, to be applied only to instruction in agriculture, the mechanic arts, the English language, and the various branches of mathematical, physical, natural, and economic science, with special reference to their applications in the industries of life and to the facilities for such instruction: *Provided*, That no money shall be paid out under this act to any State or Territory for the support and maintenance of a college where a distinction of race or color is made in the admission of students, but the establishment and maintenance of such college separately for white and colored students shall be held to be a compliance with the provisions of this act if the funds received in such State or Territory be equitably divided as hereinafter set forth: *Provided*, That in any State in which there has been one college established in pursuance of the act of July second, eighteen hundred and sixty-two, and also in which an educational institution of like character has been established, or may be hereafter established, and is now aided by such State from its own revenue, for the education of colored students in agriculture and the mechanic arts, however named or styled, or whether or not it has received money heretofore under the act to which this act is an amendment, the legislature of such State may propose and report to the Secretary of the Interior a just and equitable division of the fund to be received under this act, between one college for white students and one institution for colored students, established as aforesaid, which shall be divided into two parts, and paid accordingly, and thereupon such institution for colored students shall be entitled to the benefits of this act and subject to its provisions, as much

as it would have been if it had been included under the act of eighteen hundred and sixty-two, and the fulfillment of the foregoing provisions shall be taken as a compliance with the provisions in reference to separate colleges for white and colored students.

SEC. 2. That the sums hereby appropriated to the States and Territories for the further endowment and support of colleges shall be annually paid on or before the thirty-first day of July of each year, by the Secretary of the Treasury, upon the warrant of the Secretary of the Interior, out of the Treasury of the United States, to the State or Territorial treasurer, or to such officer as shall be designated by the laws of such State or Territory to receive the same, who shall, upon the order of the trustees of the college, or the institution for colored students, immediately pay over said sums to the treasurers of the respective colleges or other institutions entitled to receive the same, and such treasurers shall be required to report to the Secretary of Agriculture and to the Secretary of the Interior, on or before the first day of September of each year, a detailed statement of the amount so received and of its disbursement. The grants of moneys authorized by this act are made subject to the legislative assent of the several States and Territories to the purpose of said grants: *Provided*, That payments of such installments of the appropriation herein made as shall become due to any State before the adjournment of the regular session of legislature meeting next after the passage of this act shall be made upon the assent of the governor thereof, duly certified by the Secretary of the Treasury.

SEC. 3. That if any portion of the moneys received by the designated officer of the State or Territory for the further and more complete endowment, support, and maintenance of colleges, or of institutions for colored students, as provided in this act, shall, by any action or contingency, be diminished or lost, or be misapplied, it shall be replaced by the State or Territory to which it belongs, and until so replaced no subsequent appropriation shall be apportioned or paid to such State or Territory; and no portion of said moneys shall be applied, directly or indirectly, under any pretense whatever, to the purchase, erection, preservation, or repair of any building or buildings. An annual report by the president of each of said colleges shall be made to the Secretary of Agriculture, as well as to the Secretary of the Interior, regarding the condition and progress of each college, including statistical information in relation to its receipts and expenditures, its library, the number of its students and professors, and also as to any improvements and experiments made under the direction of any experiment stations attached to said colleges, with their cost and results, and such other industrial and economical statistics as may be regarded as useful, one copy of which shall be transmitted by mail free to all other colleges further endowed under this act.

SEC. 4. That on or before the first day of July in each year, after the passage of this act, the Secretary of the Interior shall ascertain and certify to the Secretary of the Treasury as to each State and Territory whether it is entitled to receive its share of the annual appropriation for colleges, or of institutions for colored students, under this act, and the amount which thereupon each is entitled, respectively, to receive. If the Secretary of the Interior shall withhold a certificate from any State or Territory of its appropriation, the facts and reasons therefor shall be reported to the President, and the amount involved shall be kept separate in the Treasury until the close of the next Congress, in order that the State or Territory may, if it should so desire, appeal to Congress from the determination of the Secretary of the Interior. If the next Congress shall not direct such sum to be paid, it shall be covered into the Treasury. And the Secretary of the Interior is hereby charged with the proper administration of this law.

SEC. 5. That the Secretary of the Interior shall annually report to Congress the disbursements which have been made in all the States and Territories, and also whether the appropriation of any State or Territory has been withheld, and if so, the reasons therefor.

SEC. 6. Congress may at any time amend, suspend, or repeal any or all of the provisions of this act.

Approved, August 30, 1890.

EXTRACTS FROM AN ACT MAKING APPROPRIATIONS FOR THE DEPARTMENT OF AGRICULTURE FOR THE FISCAL YEAR ENDING JUNE 30, 1902.

AGRICULTURAL EXPERIMENT STATIONS: To carry into effect the provisions of an act approved March second, eighteen hundred and eighty-seven, entitled "An act to establish agricultural experiment stations in connection with the colleges established in the several States under the provisions of an act approved July second, eighteen hundred and sixty-two, and of the acts supplementary thereto," and to enforce the execution thereof, seven hundred and eighty-nine thousand dollars; thirty-three thousand dollars of which sum shall be payable upon the order of the Secretary of Agriculture, to enable him to carry out the provisions of section three of said act of March second, eighteen hundred and eighty-seven, and twelve thousand dollars of which sum may be expended by the Secretary of Agriculture to investigate and report to Congress upon the agricultural resources and capabilities of Alaska; and to establish and maintain agricultural experiment stations in said Territory, including the erection of buildings and all other expenses essential to the maintenance of such stations, of which sum three thousand dollars shall be immediately available; and the Secretary of Agriculture shall prescribe the form of the annual financial statement required by section three of said act of March second, eighteen hundred and eighty-seven; shall ascertain whether the expenditures under the appropriation hereby made are in accordance with the provisions of said act, and shall make report thereon to Congress; and the Secretary of Agriculture is hereby authorized to employ such assistants, clerks, and other persons as he may deem necessary, in the city of Washington and elsewhere, and to incur such other expenses for office fixtures and supplies, stationery, traveling, freight, and express charges, illustration of the Experiment Station Record, bulletins and reports, as he may find essential in carrying out the objects of the above acts, and the sums apportioned to the several States shall be paid quarterly in advance. And the Secretary of Agriculture is hereby authorized to furnish to such institutions or individuals as may care to buy them, copies of the card index of agricultural literature prepared by the Office of Experiment Stations, and charge for the same a price covering the additional expense involved in the preparation of these copies, and he is hereby authorized to apply the moneys received toward the expense of the preparation of the index. And the Secretary of Agriculture is hereby authorized to expend twelve thousand dollars of which sum to establish and maintain an agricultural station in the Hawaiian Islands, including the erection of buildings, the printing (in the Hawaiian Islands), illustration, and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station. And the Secretary of Agriculture is hereby authorized to expend twelve thousand dollars of which sum to establish and maintain an agricultural experiment station in Porto Rico, including the erection of buildings, the printing (in Porto Rico), illustration, and distribution of reports and bulletins, and all other expenses essential to the maintenance of said station; in all, seven hundred and eighty-nine thousand dollars. * * *

NUTRITION INVESTIGATIONS: To enable the Secretary of Agriculture to investigate and report upon the nutritive value of the various articles and commodities used for human food, with special suggestions of full, wholesome, and edible rations less wasteful and more economical than those in common use; and the agricultural experiment stations are hereby authorized to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective

States and Territories, and as may be mutually agreed upon; and the Secretary of Agriculture is hereby authorized to require said stations to report to him the results of any such investigations which they may carry out, whether in cooperation with said Secretary of Agriculture or otherwise, twenty thousand dollars.

Irrigation Investigations: To enable the Secretary of Agriculture to investigate and report upon the laws and institutions relating to irrigation and upon the use of irrigation waters, with especial suggestions of better methods for the utilization of irrigation waters in agriculture than those in common use, and for the preparation, printing, and illustration of reports and bulletins on irrigation; and the agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in carrying out said investigations in such manner and to such extent as may be warranted by a due regard to the varying conditions and needs of the respective States and Territories as may be mutually agreed upon, fifty thousand dollars.

Public Road Inquiries: To enable the Secretary of Agriculture to make inquiries in regard to the system of road management throughout the United States; to make investigations in regard to the best methods of road making and the best kind of road-making materials in the several States; the employment of local and special agents, clerks, assistants, and other labor required in conducting experiments in the city of Washington and elsewhere; and in collating, digesting, reporting, and illustrating the results of such experiments; to enable the Secretary of Agriculture to investigate the chemical and physical character of road materials, for the pay of experts, chemists, and laborers, for necessary apparatus and materials; traveling and other necessary expenses, and for preparing and publishing bulletins and reports on this subject for distribution; and to enable him to assist the agricultural colleges and experiment stations in disseminating information on this subject, twenty thousand dollars. * * *

Grass and Forage Plant Investigations, Bureau of Plant Industry: * * * The agricultural experiment stations are hereby authorized and directed to cooperate with the Secretary of Agriculture in establishing and maintaining experimental grass stations, for determining the best methods of caring for and improving meadows and grazing lands, the use of different grasses and forage plants and their adaptability to various soils and climates, the best native and foreign species for reclaiming overstocked ranges and pastures, for renovating worn-out lands, for binding drifting sands and washed lands, and for turfing lawns and pleasure grounds, and for solving the various forage problems presented in the several sections of our country, twenty thousand dollars: *Provided*, That five thousand dollars of this sum, or such part thereof as the Secretary of Agriculture may deem necessary, to be immediately available.

Purchase and Distribution of Valuable Seeds: For the purchase, propagation, and distribution of valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants; the employment of local and special agents, clerks, assistants, and other labor required, in the city of Washington and elsewhere; transportation, paper, twine, gum, printing, postal cards, and all necessary material and repairs for putting up and distributing the same, and to be distributed in localities adapted to their culture, two hundred and seventy thousand dollars: * * * *Provided further*, That twenty thousand dollars of the sum thus appropriated, or so much thereof as the Secretary of Agriculture shall direct, may be used to collect, purchase, test, propagate, and distribute rare and valuable seeds, bulbs, trees, shrubs, vines, cuttings, and plants, from foreign countries for experiments with reference to their introduction into this country; and the seeds, bulbs, trees, shrubs, vines, cuttings, and plants thus collected, purchased, tested, and propagated shall not be included in general distribution, but shall be used for experimental tests, to be carried on with the cooperation of the agricultural experiment stations.

REGULATIONS OF THE POST-OFFICE DEPARTMENT CONCERNING AGRICULTURAL EXPERIMENT STATION PUBLICATIONS.

Section 372 of the Postal Laws and Regulations of the United States reads as follows: Regulations for free transmission of bulletins and reports [under the act of Congress of March 2, 1887] are prescribed as follows:

(1) Any claimant of the privilege must apply for authority to exercise it to the Postmaster-General, stating the date of the establishment of such station, its proper name or designation, its official organization, and the names of its officers; the name of the university, college, school, or institution to which it is attached, if any, the legislation of the State or Territory providing for its establishment, and any other granting it the benefits of the provision made by Congress as aforesaid (accompanied by a copy of the act or acts), and whether any other such station in the same State or Territory is considered, or claims to be, also entitled to the privilege; and also the place of its location and the name of the post-office where the bulletins and reports will be mailed. The application must be signed by the officer in charge of the station.

(2) If such application be allowed after examination by the Department, the postmaster at the proper office will be instructed to admit such bulletins and reports to the mails in compliance with these regulations, and the officer in charge of the station will be notified thereof.

(3) Only such bulletins or reports as shall have been issued after the station became entitled to the benefits of the act can be transmitted free, and such bulletins or reports may be inclosed in envelopes or wrappers, sealed or unsealed. On the exterior of every envelope, wrapper, or package must be written or printed the name of the station and place of its location, the designation of the inclosed bulletin or report, and the word "Free" over the signature, or facsimile thereof, of the officer in charge of the station, to be affixed by himself or by some one duly deputed by him for that purpose. There may also be written or printed upon the envelope or wrapper a request that the postmaster at the office of delivery will notify the mailing station of the change of address of the addressee, or other reason for inability to deliver the same, and upon a bulk package a request to the postmaster to open and distribute the "franked" matter therein in accordance with the address thereon.

Bulletins published by the United States Department of Agriculture and analogous to those of the station, and entitled to be mailed free under the penalty envelope of that Department, may also be adopted and mailed by the several stations, with their own publications, under the same regulations, and any bulletins or reports mailable free by any agricultural experiment station under these regulations may be so mailed by any other station having free-mailing authority.

If such station's annual reports be printed by State authority, and consist in part of matter relating to the land-grant college to which such station is attached, then said report may be mailed free entire by the director of the station; provided, in his judgment, the whole consists of useful information of an agricultural character.

(4) The bulletins may be mailed to the stations, newspapers, or persons to whom they are by the foregoing act authorized to be sent, and the annual reports to any address within the United States, Canada, Mexico, or Hawaiian Kingdom (Sandwich Islands), but not to other foreign countries, free of postage.

An order of the Postmaster-General dated January 3, 1899, provides "That any article entitled to transmission free of postage in the domestic mails of the United States, either in a 'penalty' envelope or under a duly authorized 'frank,' shall be entitled likewise to transmission by mail free of postage between places in Hawaii, Cuba, Porto Rico, and the Philippine Islands; from the United States to those islands, and from those islands to the United States."

Among rulings on matters of detail the following are the most important.

"In sending out bulletins from an agricultural experiment station it is permissible to inclose postal cards to enable correspondents of the station to acknowledge the receipt of its publications and to request their continuous transmission.

"Copies of the reports or bulletins of the agricultural experiment stations, which are purchased, paid, or subscribed for, or otherwise disposed of for gain, when sent in the mails, are not entitled to free carriage under the 'frank' of the director of the station."

Station bulletins and reports, consisting of typewritten matter duplicated on a mimeograph or other duplicating machine, "retain their character as free matter when properly franked by the director of the station."

Reports of State boards of agriculture or other State boards, commissioners, or officers, even though they contain station bulletins and reports, can not be sent free through the mails under the frank of the director of the station.

The catalogue of the college of which the station is a department can not be sent free through the mails under the frank of the director of the station, whether said catalogue is published separately or is bound together with a station publication.

RULINGS OF THE TREASURY DEPARTMENT AFFECTING AGRICULTURAL EXPERIMENT STATIONS.

From copies of letters addressed to the Secretary of the Treasury and others by the First Comptroller of the Treasury, relating to the construction of the act of Congress of March 2, 1887, and acts supplementary thereto, the following digest has been prepared for the use of the stations. The sections are those of the act, the dates those of the decisions by the Comptroller:

SECTION 3—JANUARY 30, 1888.

That the annual financial statement of the stations, with vouchers, should not be sent to the Treasury Department, but that a copy simply of the report that is made to the governor is to be sent to the Secretary of the Treasury.

SECTION 3—JANUARY 31, 1888.

First. That the Treasury Department will not require officers of experiment stations to do or perform anything not specifically required by said bill.

Second. That the Secretary of the Treasury is not required to take a bond of the officers of said stations for the money paid over under the provisions of said act.

Third. That no reports will be required from the stations directly to the Secretary of the Treasury; but the governor of the State must send to the Secretary of the Treasury a copy of the report made to him by the colleges or stations.

SECTION 4—DECEMBER 16, 1895.

The Solicitor of the Treasury writes: "I am of the opinion that there is no authority for an agricultural experiment station to sell its bulletins outside of the State or Territory. Congress appropriates for the publication and free distribution of the bulletins, and neither expressly nor by necessary implication authorizes their sale."

SECTION 6—AUGUST 2, 1888.

The fiscal year commences on the 1st day of July, corresponding with the fiscal year of the Government.

An agricultural station entitled to the benefits of said appropriations made by Congress can anticipate the payment to be made July 1, and make contracts of purchases prior to that time, if it shall be necessary to carry on the work of the station.

Of course, no portion of said appropriations paid in quarterly installments can be drawn from the Treasury unless needed for the purposes indicated in the act; and so much of what is so drawn as may not have been expended within the year must be accounted for as part of the appropriation for the following year.

SECTION 8—JANUARY 30, 1888.

The State of New York ought to designate whether to the college or to the station, or to both, it desires the appropriation to be applied. The eighth section of the act seems to authorize the State to apply such benefits to experimental stations it may have established as it desires.

Where there are no experimental stations connected with the colleges, the legislatures of such States must connect the agricultural experiment station with the colleges already established under the act of July 2, 1862; there is no authority in the act authorizing the establishment of agricultural experiment stations independent of said colleges.

The act contemplates that where stations have already been established disconnected from the colleges, the legislatures of such States may make such provisions in regard thereto as they may deem proper; but it does not authorize the establishment of stations except in connection with the colleges that were at that time or might thereafter be established under the act of July 2, 1862.

SECTION 8—FEBRUARY 14, 1888.

Where there is an agricultural college or station which may have been established by State authority, and is maintained by the State, the eighth section of the above act would authorize the State to designate the station to which it desired the appropriation to be applied, whether to one or more, or all, and the Secretary of the Treasury should make the payment under the appropriation to whichever one the State might designate.

SECTIONS 1 AND 8—FEBRUARY 15, 1888.

(1) When an agricultural college or station has been established under the act of July 2, 1862, each college is entitled to the benefits of the provisions of said act (i. e., of March 2, 1887).

(2) In a State where an agricultural college has been established under the act of July 2, 1862, and agricultural stations have also been established, either under the act of July 2, 1862, or by State authority, before March 2, 1887, the legislature of such State shall determine which one of said institutions, or how many of them, shall receive the benefits of the act of March 2, 1887.

(3) If the legislature of any State in which an agricultural college has been established under the act of July 2, 1862, desires to establish an agricultural station which shall be entitled to the benefits of said act, it must establish such station in connection with said college.

PROVISO TO SECTIONS 1 AND 8—DECEMBER 7, 1888.

It is within the power of the legislature of any State that has accepted the provisions of said act of March 2, 1887, to dispose of the amount appropriated by Congress for said station to either one or all of the agricultural colleges or stations which may have been established in said State by virtue of either the provisions of the act of July 2, 1862, or the provisions of said eighth section of the act of March 2, 1887.

The whole responsibility rests upon the State legislature as to how the fund appropriated by Congress shall be distributed among these various institutions of the State, provided there is one or more agricultural colleges with which an agricultural station is connected, or one or more agricultural stations.

RULINGS OF THE DEPARTMENT OF AGRICULTURE ON THE WORK AND EXPENDITURES OF AGRICULTURAL EXPERIMENT STATIONS.[a]

In connection with examinations of the work and expenditures of the agricultural experiment stations established in accordance with the act of Congress of March 2, 1887, under authority given to the Secretary of Agriculture by Congress, questions have arisen which have seemed to make it advisable to formulate the views of this Department on certain matters affecting the management of the stations under that act. The statements given below have therefore been prepared to cover the points which seem to require special attention:

EXPENDITURES FOR PERMANENT SUBSTATIONS.

This Department holds that the expenditure of funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, for the maintenance of permanent substations is contrary to the spirit and intent of said act. The act provides for an experiment station in each State and Territory, which, except in cases specified in the act, is to be a department of the college established under the act of Congress of July 2, 1862. The objects of the stations, as defined in the first-mentioned act, are evidently of such a character as to necessitate the services of scientific and expert workers. Most of the lines of investigation named in the act are general, rather than local, and involve scientific equipment and work. It is obviously the intent that the stations established under this act shall carry on important investigations which shall be of general benefit to the agriculture of the several States and Territories. The sum of $15,000, which is annually appropriated by Congress under this act for each station, is only sufficient to carry out a limited number of investigations of the kind contemplated by the act.

As the work of the stations in the different States has developed, it has been found necessary to limit, rather than expand, the lines of work of the individual stations. Thorough work in a few lines has been found much more effective and productive of more useful results than small investigations in numerous lines. When we consider the nature of the investigations, the amount of money provided for the work of each station, and the fact that the act expressly provides for only a single station in connection with each college, it becomes very clear that expenditures such as are necessary to effectively maintain permanent substations ought not to be made from the funds granted by Congress to the States and Territories for experiment stations. The maintenance of permanent substations as a rule involves the erection of buildings and the making of other permanent improvements. The sums of money which can be expended for permanent improvements under the act of Congress aforesaid are so small that it is clear they were not intended to meet the needs of more than one station in each State and Territory.

When the legislature of a State or Territory has given its assent to the provisions of the act of Congress of March 2, 1887, and has designated the institution which shall receive the benefits of said act, it would seem to have exhausted its powers in the matter. The responsibility for the maintenance of an experiment station under said act devolves upon the governing board of the institution thus designated. If the legislature of the State or Territory sees fit to provide funds for the equipment and maintenance of other experiment stations and to put them under the control of the same governing board, well and good, but this does not in any way diminish the responsibility of the board to administer the funds granted by Congress in accordance with the provisions of said act.

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[a] U. S. Dept. Agr., Office of Experiment Stations Circular 29.

The wisdom of Congress in limiting the number of stations to be established in each State and Territory under the aforesaid act has been clearly shown by the experience of the few States and Territories which have attempted the maintenance of substations with the funds granted under said act. The expense of maintaining substations has as a rule materially weakened the central station, and the investigations carried on at the substations have been superficial and temporary. It is granted that in many States and Territories more than one agricultural experiment station might do useful work, and in some States more than one station has already been successfully maintained; but in all these cases the State has given funds from its own treasury to supplement those given by Congress. It is also granted that experiment stations established under said act of Congress and having no other funds than those provided by that act will often need to carry on investigations in different localities in their respective States and Territories, but it is held that this should be done in such a way as will secure the thorough supervision of such investigations by the expert officers of the station and that arrangements for such experimental inquiries should not be of so permanent a character as to prevent the station from shifting its work from place to place as circumstances may require, nor involve the expenditure of funds in such amounts and in such ways as will weaken the work of the station as a whole.

As far as practicable, the cooperation of individuals and communities benefited by these special investigations should be sought, and if necessary the aid of the States invoked to carry on enterprises too great to be successfully conducted within the limits of the appropriation granted by Congress under the act aforesaid.

PURCHASE OR RENTAL OF LANDS FOR AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that the purchase or rental of lands by the experiment stations from the funds appropriated in accordance with the provisions of the act of Congress of March 2, 1887, is contrary to the spirit and intent of said act. The act provides for "paying the necessary expenses of conducting investigations and experiments and printing and distributing the results. * * * *Provided, however,* That out of the first annual appropriation so received by any station an amount not exceeding one-fifth may be expended in the erection, enlargement, or repair of a building or buildings necessary for carrying on the work of such stations; and thereafter an amount not exceeding 5 per centum of such annual appropriation may be so expended." The only reference to land for the station in the act is in section 8, where State legislatures are authorized to apply appropriations made under said act to separate agricultural colleges or schools established by the State "which shall have connected therewith an experimental farm or station." The strict limitation of the amount provided for buildings and the absence of any provision for the purchase or rental of lands, when taken in connection with the statement in the eighth section, which treats the farm as in a sense a necessary adjunct of the educational institution to which the whole or a part of the funds appropriated in accordance with said act might in certain cases be devoted, point to the conclusion that it was expected that the institution of which the station is a department would supply the land needed for experimental purposes and that charges for the purchase or rental of lands would not be made against the funds provided by Congress for the experiment station. This conclusion is reenforced by consideration of a wise and economic policy in the management of agricultural experiment stations, especially as relating to cases in which it might be desirable for the station to have land for experimental purposes in different localities. The investigations carried on by the stations in such cases being for the direct benefit of agriculture in the localities where the work is done, it seems only reasonable that persons or communities whose interests will be advanced by the station work should contribute the use of the small tracts of land which will be required for experimental purposes. Experience shows that in most cases the stations have had no difficulty in securing such land as they

needed, without expense, and it is believed that this may be done in every case without injuriously affecting the interests of the stations.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR CARRYING ON FARM OPERATIONS.

This Department holds that expenses incurred in conducting the operations of farms, whether the farms are connected with institutions established under the act of Congress of July 2, 1862, or not, are not a proper charge against the funds appropriated by Congress for agricultural experiment stations in accordance with the act of Congress of March 2, 1887, unless such operations definitely constitute a part of agricultural investigations or experiments planned and conducted in accordance with the terms of the act aforesaid under rules and regulations prescribed by the governing board of the station. The performance of ordinary farm operations by an experiment station does not constitute experimental work. Operations of this character by an experiment station should be confined to such as are a necessary part of experimental inquiries. Carrying on a farm for profit or as a model farm, or to secure funds which may be afterwards devoted to the erection of buildings for experiment station purposes, to the further development of experimental investigation, or to any other purpose however laudable and desirable, is not contemplated by the law as a part of the functions of an agricultural experiment station established under the act of Congress of March 2, 1887. Section 5 of that act plainly limits the expenditures of funds appropriated in accordance with said act to "the necessary expenses of conducting investigations and experiments and printing and distributing the results."

FUNDS ARISING FROM THE SALE OF FARM PRODUCTS OR OTHER PROPERTY OF AN AGRICULTURAL EXPERIMENT STATION.

This Department holds that moneys received from the sales of farm products or other property in the possession of an agricultural experiment station as the result of expenditures of funds received by the station in accordance with the act of Congress of March 2, 1887, rightfully belong to the experiment station as a department of the college or other institution with which it is connected, and may be expended in accordance with the laws or regulations governing the financial transactions of the governing board of the station, provided, however, that all expenses attending such sales, including those attending the delivery of the property into the possession of the purchaser, should be deducted from the gross receipts from the sales and should not be made a charge against the funds appropriated by Congress.

LIMIT OF EXPENDITURES OF EXPERIMENT STATIONS DURING ONE FISCAL YEAR.

This Department holds that expenses incurred by an agricultural experiment station in any one fiscal year to be paid from the funds provided under the act of Congress of March 2, 1887, should not exceed the amount appropriated to the station by Congress for that year, and especially that all personal services should be paid for out of the appropriation of the year in which they were performed, and that claims for compensation for such services can not properly be paid out of the appropriations for succeeding years. The several appropriations for experiment stations under the aforesaid act are for one year only, and officers of experiment stations have no authority to contract for expenditures beyond the year for which Congress has made appropriations.

This is plainly implied in the act aforesaid, inasmuch as section 6 provides that unexpended balances shall revert to the Treasury of the United States, "in order that the amount of money appropriated to any station shall not exceed the amount actually and necessarily required for its maintenance and support." The annual financial report rendered in the form prescribed by this Department should in every

case include only the receipts and expenditures of the fiscal year for which the report is made.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR A WATER SYSTEM TO BE CHARGED UNDER "BUILDINGS AND REPAIRS."

This Department holds that expenditures by agricultural experiment stations from the funds appropriated in accordance with the act of Congress of March 2, 1887, for the construction of wells, cisterns, ponds, or other reservoirs for the storage of water, and for piping, and other materials for a system of storing and distributing water, are properly charged, under abstract 18 in the schedule for financial reports prescribed by this Department, as being for improvements on lands which have hitherto been held to come under the head of "building and repairs." The fact that a water system may be a necessary adjunct of certain experimental inquiries does not affect the case, inasmuch as the limitations on expenditures for improvements contained in section 5 of the act of Congress of March 2, 1887, expressly stipulate that these improvements shall be such as are necessary for carrying on the work of the station.

EXPENDITURES BY AGRICULTURAL EXPERIMENT STATIONS FOR MEMBERSHIP IN AGRICULTURAL AND OTHER ORGANIZATIONS.

This Department holds that membership fees in associations and other organizations are not a proper charge against the funds appropriated by Congress in accordance with the act of March 2, 1887, except in the case of the Association of American Agricultural Colleges and Experiment Stations, which is held to be an essential part of the system of experiment stations established under said act.

THE BORROWING OF MONEY TO PAY THE EXPENSES OF AGRICULTURAL EXPERIMENT STATIONS.

This Department holds that experiment station officers have no authority to borrow money to be repaid out of appropriations made under the act of Congress of March 2, 1887, and that charges for interest can not properly be made against funds appropriated under that act.

A. C. TRUE, *Director.*

Approved:

J. STERLING MORTON, *Secretary.*

WASHINGTON, D. C., *March 10, 1896.*

THE USE OF EXPERIMENT STATION FUNDS FOR COLLEGE PURPOSES.

This Department holds that no portion of the funds appropriated by Congress in accordance with the act of March 2, 1887, can legally be used, either directly or indirectly, for paying the salaries or wages of professors, teachers, or other persons whose duties are confined to teaching, administration, or other work in connection with the courses of instruction given in the colleges with which the stations are connected or in any other educational institution; nor should any other expenses connected with the work or facilities for instruction in school or college courses be paid from said fund. In case the same persons are employed in both the experiment station and the other departments of the college with which the station is connected a fair and equitable division of salaries or wages should be made, and in case of any other expenditures for the joint benefit of the experiment station and the other departments of the college the aforesaid funds should be charged with only a fair share of such expenditures.

Respectfully,

A. C. TRUE, *Director.*

Approved:

JAMES WILSON, *Secretary of Agriculture.*

WASHINGTON, D. C., *October 25, 1897.*

ANNUAL REPORT OF THE ALASKA AGRICULTURAL EXPERIMENT STATIONS FOR 1902.

By C. C. Georgeson, *Special Agent in Charge.*

The agricultural work during the current year at the Alaska experiment stations may be briefly summarized as follows:

At the headquarters station we have grown experimentally all the leading hardy grains, grasses, and vegetables. We have made a start toward the establishment of a nursery by the propagation of a number of currant, gooseberry, and raspberry plants; by procuring a small collection of hardy fruit trees, hardy ornamental bushes, and perennials, and also a collection of some 10 varieties of strawberries.

The headquarters building has been partially completed in that the stone foundation, which the plans called for, has been filled in between the piers on which the building was erected, the porch has been completed, the stairs built, and two rooms have been finished upstairs. Besides this, a heating plant should be put in the building and the other two rooms in the second story should be finished, and arrangements are being made to have this work done during the winter.

On the farm, a kitchen and a porch have been added to the cottage, a blacksmith shop has been built, the roof of the barn has been extended so as to cover the silo, and the silo itself has been enlarged by building it 8 feet higher.

In the way of improvement of new land comparatively little has been done on account of the unceasing rains. We have cleared about half an acre and finished the under drainage of the 2 acres of marsh land referred to in former reports.

Seed has been distributed to about 750 residents in all parts of the Territory, and Bulletin No. 1, entitled "Suggestions to Pioneer Farmers in Alaska" has been issued.

At the Kenai Station experimental crops of all the hardy grains and vegetables have been grown. About 8 acres of new land have been cleared and made ready for the plow, and a beginning has been made in animal husbandry by the acquisition of a cow and a calf.

At the Rampart Station small patches of winter rye, spring wheat, barley, and oats have been grown to perfect maturity by one of the residents of the town. We have no one regularly employed at this station.

Perhaps the most important work of the season has been the establishment of an experiment station in the Copper River Valley. A competent and experienced man has been placed in charge of this new station. Some patches of ground have been dug up by hand and seeded to winter grain, and 8 acres more have been cleared and made ready for the plow as soon as spring opens. A team of horses has been acquired for this station, and the necessary agricultural implements with which to begin work have been purchased.

We have, in addition, as in former years, maintained meteorological and soil temperature observations at our several stations, and the writer has had supervision of all the voluntary observers of the Weather Bureau in Alaska, and, as a matter of course, the constantly increasing volume of correspondence has been maintained.

WORK AT SITKA STATION.

WEATHER CONDITIONS.

For the first time during the five seasons these investigations have been in progress, I have to report unsuccessful efforts in grain growing, owing to excessive rains. The early part of the season was promising. During April, May, and June we had more than the usual amount of sunshine. The soil dried out well for spring planting and all the crops were put in under auspicious conditions. They made an excellent start and until the end of June there were prospects for the best crops yet produced, but then the good weather ceased. During July we had but 4 clear days, and during August and September together only 1 clear day, or to be more exact, we did not have a single clear day between July 9 and September 18. That is, for a period of 69 days in succession, during the time when growing crops need sunshine the most, we did not have a full clear day. The sun would come out for an hour or two occasionally, but seldom enough to dry the rain off vegetation and never enough to dry the surface of the ground. It rained on 74 days out of the 92 days in July, August, and September, and the precipitation amounted to nearly 3 feet, lacking but one-quarter of an inch. The result was that the grain continued to grow abnormally late and when it finally matured it was almost impossible to save it. We had to adopt methods which would not be practicable where farming operations are carried out on a moderately large scale. We had to set the grain up against fences and other artificial supports to drain the water off, and when the wind had partially dried out the heads we had to watch our chance to put it under shelter. Some of it was tied in small bunches and hung up in the barn and elsewhere, where air currents could dry it out. By these means we have succeeded in saving all of our rye and wheat and part of the barley and oats, but, of course, such methods are not to be recommended for any but small farms.

It is to be noted that there was no crop failure. Vegetation was most luxuriant. Wheat stood between 4 and 5 feet high and rye over 6 feet. Nor was there any detrimental cold weather. As a matter of fact, the growing season has been very long and the temperature favorable throughout. The temperature did not fall to 32° F. between April 26 and October 18. The unfavorable conditions were due wholly to an abnormally heavy rainfall. Similar conditions are of course constantly occurring in the States also. It is often the case in Washington and Oregon west of the mountains, and in other places and over vast areas even more disastrous results are occasioned by the lack of rain. This instance should therefore not be considered as disqualifying Alaska for successful agriculture. Moreover, only the coast region has been affected. In the interior grain has been successfully brought to maturity at several widely separated places. This explanation is pertinent before we take up the crops in detail.

FIELD CROPS.

As former tests have narrowed down the number of varieties which do well here, the list selected for the present year's experiments is not a lengthy one.

WINTER RYE.

Excelsior.—This variety of winter rye was seeded on a small patch September 7, 1901. It came up well and made a fine start, but it suffered somewhat from too much wet during the winter. It began to grow early in the spring. By May 15 it was 16 inches high. It began to head May 24. On June 2 the average height of the patch was 42 inches, and three-fourths of it was headed. June 16 it was fully headed, and 5 feet 8 inches in height. June 23 it was in full bloom. July 1 it had passed the blooming stage and was forming grain. It then averaged 6 feet in height. July 15 some of the grain was in the milk and the crop stood 6½ feet high. August 1 the heads were heavy with grain, much of which was in the dough, and the straw had begun to color. August 15 it was far enough advanced to be harvested had the weather permitted; but as it had a strong, elastic straw, which stood up well during the storms, it did not suffer. September 1 it was fully ripe, but still left standing to await favorable weather. September 9 it had begun to break down and was therefore cut and placed in a drafty place on the barn floor to dry, by setting it up against improvised supports.

The heads of this variety are rather short and the grain is not large. The writer does not consider it quite as good as the Swedish winter rye reported on last year. Its ability to stand up during stormy weather is an important qualification for Alaska, and it may be added to the list of varieties which can be grown successfully in the Territory.

WHEAT-RYE.

Carman wheat-rye.—The late Mr. E. S. Carman, proprietor of the Rural New Yorker, originated a hybrid between wheat and rye, and we succeeded in securing a small amount of the seed from J. M. Thorburn & Co., seedsmen, in New York. This grain was seeded on a small plat adjacent to the rye just mentioned and on the same date, September 7. It made a fair start and grew slowly during the fall. During the winter many of the plants were killed out by wet weather. Those which remained started to grow early in the spring, but the growth was slow. June 2 it was 2 inches high and the stand thin. June 16 it was 26 inches high and considerably improved. June 23 it was heading and beginning to bloom. July 1 it was fully headed and in full bloom. July 15 the grain had formed. It stood up well, measuring 4½ feet, and seemed more promising than spring wheat. August 1 the grain was passing from milk to dough. The heads were short, but well filled, and on August 15 it was beginning to ripen. A few plants seemed to be earlier than the rest. September 1 it was ripe, but not harvested on account of the weather. September 9 the grain had started to sprout in a large percentage of the heads, although the straw stood upright. It was then cut and dried under shelter. Most of the grain raised was seeded at once in order to perpetuate the strain.

This variety, although an alleged hybrid between wheat and rye, resembles wheat. Its appearance does not give the slightest suspicion of rye, excepting, perhaps, the quality of a more than ordinarily strong and elastic straw. But the straw is thick and yellow in color, not slender and pale, as in the rye straw. The heads are brown, mostly smooth, though a few have beards of moderate length; the spikelets are broad and rather far apart, and the grain resembles plump white wheat. It is hoped that in another year we may get grain enough to test it in different places and on a larger scale.

SPRING WHEAT.

We grew two patches of wheat the past season, one on old ground and the other on new ground. Both were seeded with the same variety, namely, the Romanow, which previous tests have proved to be the variety best adapted to Alaska.

Romanow (on old ground).—Seeded on May 2, by May 10 it showed a fine stand. June 2 it was 8 inches high and growing rapidly. June 16 it showed a magnificent stand and growth. It was then but 6 weeks from the time of seeding, yet it was on an average 18 inches high, and the best was 2 feet high. July 1 it was 27 inches high and had tillered so as to make it rather thick in places. July 15 it was headed. The rain storms had set in and caused it to lodge in places. If it should all lodge, the crop would be a total failure, so to save it we

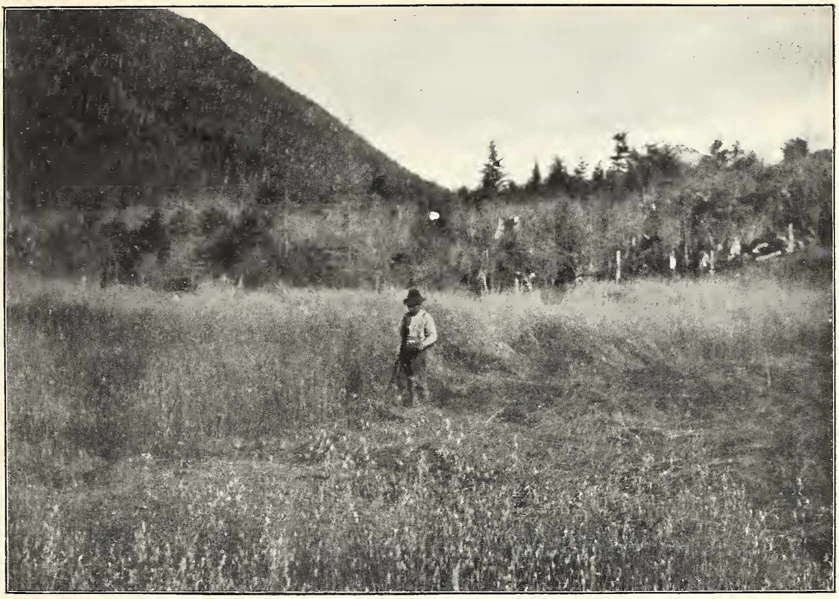


FIG. 1.—ALASKA STATIONS—OAT FIELD, SITKA.

FIG. 2.—ALASKA STATIONS—STATION BUILDING, SITKA.

stretched strings at intervals to support it. It was then passing out of bloom. August 1 the crop stood 4 to 5 feet high and the grain was mostly in the milk. August 15 the grain was passing from milk to dough and the straw measured upward of 5 feet. September 1 most of it was still in the dough, though some was beginning to harden. At this date many new heads were appearing from young shoots, which were, of course, too late to mature grain. This was caused by the persistent rain. September 15 it was ripe enough to cut, if it had been dry, but it was left standing to await fair weather. It was finally cut September 23 and hung under shelter October 1. At this date some of the grain had started to grow in the heads.

Romanow (on new ground).—Seeded May 12. June 2 it was 3 inches high and showed a fair stand. June 16 it was 6 inches high and looked well. July 1 it was 15 inches high. July 15 the best was 2½ feet high, but the average not more than 2 feet. It had not begun to head at this date. August 1 it had headed and was in bloom and 3 feet high. August 15 most of it was still in bloom, though the grain was half grown in the earliest heads. At this date it ranged from 4 to 4½ feet in height and stood up well in spite of the storms. September 1 the earliest heads were in the milk and most of the grain was only half grown. September 15 the grain was full grown, but still green. October 1 it was beginning to ripen, and it was harvested October 15. It did not lodge badly.

OATS.

Sixty-day.—This variety was imported by the United States Department of Agriculture from Finland. It was seeded May 8, germinated rather slowly, and did not make much of a show above ground until May 24. June 2 it was 2 inches high and stand uneven. June 16 grass and weeds began to crowd the crop, which averaged about 6 inches high. July 1 the average height was 12 inches, though the best of it was 1½ feet and heads beginning to show. July 15 it was all headed and in bloom; height, about 18 inches. August 1 the grain about half grown; height, 2 feet 4 inches. August 15 the grain was passing from milk to dough. It had lodged in spots. September 1 it was ripe and could have been harvested if weather had permitted. It was finally cut September 11, and suffered much from the wet. Part of the crop was saved for seed by drying it in the barn. Like other varieties of oats, it is not a heavy yielder, and the straw is slender, so that it does not stand up well. The grain is small and yellow. Its earliness is it chief recommendation.

North Finnish Black (on new ground) (Pl. IX, fig. 1).—Seed grown at Sitka Station in 1901. Seeded May 28. June 16, 3 inches high. July 1, 8 inches high; stand somewhat uneven. July 15, the best is 18 inches high; growth still uneven. August 1, 4 feet high.

It makes a fine showing and at this date it is the most promising variety of oats at the station. August 15, the earliest seed is in the milk. The crop is not advancing evenly; there are many young shoots in various stages of growth. September 1, the earliest panicles are ripe, but the crop as a whole is still green and it is lodging in places. September 15, ripe, and could be harvested if the weather permitted. October 1, still awaiting dry weather. October 23, harvested but in poor condition. The straw was beaten down by the rain and the grain was very largely spoiled.

Burt Extra Early (on new ground).—Seeded May 27. June 16, it was 3 inches high and showed a good stand. July 1, the growth was uneven, average height 10 inches. July 15, growth irregular, the best 16 inches high; a few heads showing. August 1, 3½ feet high, headed and beginning to bloom. August 15, the earliest of the grain is half grown, but some panicles still in bloom; growth uneven. September 1, it has thrown out suckers from the roots, which are later than the earlier panicles. As a whole the crop is still green and it has lodged in places. The best is 4 feet tall. September 15, the crop is ripe and would be harvested if the weather permitted. October 1, the whole plat flat on the ground and being spoiled by wet weather. It was cut for feed.

Swedish Select (on new ground).—Seed obtained from the Montana Experiment Station. Seeded May 28. June 16, 3 inches high and a good stand. July 1, average height 8 inches, and the crop looks promising. August 1, 3 feet high, fairly even in growth, heading out, but not in bloom yet. August 15, in bloom and seed beginning to form; 4 feet high. September 1, grain in the milk. It has a good straw and stands up well under the strain of severe storms. Best, 4½ feet high. September 15, the crop is ripe and could be harvested if the weather permitted. October 23, cut; harvest has been delayed on account of the rain. This variety has suffered comparatively little. The grain is large and plump.

White Russian (on new ground).—Seeded May 27. June 16, 2 inches high and a good stand. July 1, the growth is uneven. It looks well only in spots; 6 inches high. July 15, growth continues irregular, the best 20 inches high; not heading yet. August 1, it varies in height from 6 inches to 4 feet, headed out. August 15, has made but little progress in the last two weeks. September 1, in bloom and grain forming. The irregular growth is due to the soil. The crop will be useful only as feed. This variety has been grown very successfully at this station in former years.

Improved Ligowa (on new ground).—Seeded May 27. June 16, 2 inches high and a fine stand. July 1, only one-half of the plat looks well; the other half is stunted, the best 6 inches high. July 15, growth irregular, the best 16 inches high, not heading yet. August 1, 3½ feet

high, headed, but not in bloom. August 15, in bloom, but otherwise no improvement. September 1, grain forming, crop fit for feed only. This variety has been grown successfully at this station in former years. The uneven growth is due to the soil.

BARLEY.

Manshury (on new ground).—Seed obtained from Minnesota Experiment Station. Seeded May 15. Came up May 27. June 2 it was 3 inches high and showed a fine stand. June 16, 5 inches high, a little irregular in growth. July 1, the best is 15 inches high. July 15, heading out, height 2 feet. August 1, 3 feet in height and the earliest grain in milk. August 15, most of it still in the milk and crop looks well. September 1, beginning to turn yellow. September 15, ripe, and harvested September 18.

Lapland.—Two patches were sown in this variety, one with Sitka-grown seed of last year's crop, and one with imported seed from Lapland. The two patches behaved alike in all particulars and it was impossible to detect any difference in growth. The two are therefore treated here as one. Seeded May 12. Came up May 26. June 2, 3 inches high, stand fair. June 16, 5 inches high, growing nicely. July 1, 15 inches high, looks promising. July 15, beginning to show some irregularity in growth; the best is 2½ feet high and heading. August 1, in milk, from 2½ to 3 feet high. New shoots are coming from the roots. August 15, the earliest heads are passing from milk to dough, but many young shoots are in all stages of growth, for which reason the crop can not be harvested. September 1, the earliest is fully ripe, but new shoots continue to spring from the roots. September 15, flat on the ground, beaten down by the rain; much of it is still too green to harvest. October 1, it can now be harvested, but no prospect of drying the crop. October 9, harvested.

Sisolsk.—Seed grown at the Sitka Station in 1901. Seeded May 12. Came up May 27. June 2, 3 inches in height, stand fair. June 16, 5 inches high. July 1, looks very promising, 15 inches high. July 15, heading out, 2 feet 5 inches high. August 1, 3 feet high, grain in the milk, a very fine crop. August 15, developing somewhat unevenly; some of the grain has advanced to the dough state, while most of it is still less than half grown. The grain is unevenly developed in the same head in some cases. September 1, the earliest heads are ripe, but much of it is too green to harvest. September 15, ripe, but rain prevents harvesting. October 8, cut, but badly damaged.

Black Hulless.—Seeded May 12. Came up May 27. June 2, 2 inches high. June 16, 4 inches high. July 1, the crop is becoming uneven in growth, the best 15 inches in height. July 15, heading, 2 feet high. August 1, 2½ feet high, the earliest in the milk. August 15, most of it still in the milk. September 1, ripe, but too wet to cut. Septem-

ber 15, the whole crop beaten down flat on the ground. October 1, the continuous wet weather has spoiled the grain. This variety is very early and may be depended upon to mature grain every year in Alaska, but the heads are short, and it is a poor yielder. The writer has recommended it for culture by the natives because, being hulless, it can be boiled and eaten without being ground.

FLAX.

A patch of Riga flax was seeded thickly May 23 for fiber. The following notes were taken on its growth: June 2, just appearing above ground. June 16, the crop showed a fine stand, plants 1 inch high. July 1, 6 inches high. July 15, uniform crop 2 feet high and beginning to bloom. The rains have caused it to lodge in places. August 1, from 30 inches to 3 feet high. August 15, passing out of bloom; the growth is heavy, but three-fourths of the crop has lodged badly. September 1, it has changed but little during the past two weeks; as yet no ripe seeds. September 15, about 5 per cent of the seed is ripe. October 8, crop pulled. That portion which has not lodged will make a fine quality of flax.

HEMP.

Common Hemp.—Seeded May 23. June 16, showed a poor, scattering stand. The seed apparently was not good, and part of it was eaten by the chickens and pigeons. July 1, only a few plants to be seen. July 15, condition fair, averages about 18 inches high. August 1, 3 feet high, no bloom showing. August 15, 4 feet high. September 1, in bloom, growing slowly. September 15, average height about 5 feet. October 8, the crop was cut and produced a fairly tough fiber. This experiment, however, can not be considered a fair test, as the soil was very poor.

FURZE (*Ulex europæus*).

Seeded May 10. The seed had been tested and only 3.75 per cent was found to germinate. It was therefore steeped in hot water before seeding, and the result was that apparently every seed grew. June 16, ½ inch high. July 15, 2 inches high. August 1, 4 inches high. September 1, 7 inches high. This plant is used to some extent as a forage plant in Scotland, and it is for this purpose that it was tested here. Being a shrub, it grows but slowly the first year.

BUCKWHEAT.

Seed from Berlin, Conn. June 16, just coming up, fair stand showing. June 26, 2 inches high; the stand is good, but the color is poor. July 1, 4 inches high, beginning to bloom. July 15, the best 1 foot high and in bloom. August 1, continues uneven in growth, due to

the soil; best $1\frac{1}{2}$ feet high, all in full bloom, and grain forming. August 15, going out of bloom, the earliest grain fully developed, but owing to the rainy weather a large percentage of the flowers failed to set seed. September 1, ripe and harvested. It was grown on new ground.

GRASSES.

The following grasses were seeded broadcast May 14 on rather poor new ground. In a few cases the seed was not good and in two instances it failed to grow altogether; but on the whole the plats show a very satisfactory growth. The conditions noted on August 1 were as follows:

Water grass (*Poa aquatica*).—Failed to grow.

Meadow foxtail.—This grass showed a good stand, but the height was only about 6 inches.

Tall meadow oat grass.—This grass showed a splendid stand, and on August 1 was about 2 feet tall. It had made the best growth of all of the varieties seeded.

Kentucky blue grass.—On August 1 this plat showed a fine stand, but the growth was light, being not over 6 inches.

Tall meadow fescue.—On August 1 the stand was fairly good, but the height was only 5 inches.

Redtop.—This grass made a good stand and a fair growth; somewhat uneven. On August 1 it was 6 inches to 1 foot high.

Timothy.—This grass, so highly esteemed in the East, made a fine stand, but was uneven in growth. On August 1 it measured 6 inches to 18 inches tall, and some of it was heading. At the same date volunteer timothy in its second year was $4\frac{1}{2}$ feet high and seeding.

Orchard grass.—This and the following were seeded with Dwarf Essex rape, which choked it partly, or at least retarded the growth. On August 1 it was but 3 inches high, but the stand was good.

Smooth brome grass.—This, too, was partly choked by the rape, but on August 1 it was 4 inches high.

Perennial rye grass.—This grass showed a splendid stand, but was likewise retarded by the rape. It was but 3 inches high August 1.

Red clover and white clover were likewise seeded on new ground. They made a light and rather unsatisfactory growth. On old ground, however, as I have heretofore reported, these clovers will make a vigorous growth and produce as much forage to the acre as anywhere. Some volunteer plants of red clover in their second year measured 3 feet high, and matured seed by the last of August.

VEGETABLES.

The common hardy vegetables were again grown at the Sitka Station the past season, partly on old ground and partly on new ground. The

varieties grown on old ground developed rapidly and attained a large size, while the varieties grown on new ground were not quite so successful. This bears out the experience, which is almost universal in Alaska, and which has been emphasized in former reports, that new ground is comparatively unproductive, and that the best results are obtained when the soil has been in cultivation for several years. The varieties grown may be briefly enumerated as follows:

Cabbage—Early Jersey Wakefield; cauliflower—Early Snowball, Extra Early Erfurt, and Broccoli; kale—Scotch Curled; Brussels sprouts—Improved Dwarf. All of these were seeded in a hotbed April 15 and the plants set out in the open May 25. By August 1 the earliest heads of both cabbage and cauliflower could be used for the table. The largest heads raised measured a foot in diameter. It should be noted in this connection that a market gardener at Juneau had cauliflower on the market July 4. The plants were raised in a hotbed and planted in the open the middle of May. The kale and Brussels sprouts developed normally.

Two varieties of peas, American Wonder and Alaska, were planted on new ground in the middle of May and produced marketable peas by the middle of July. Golden Wax beans were planted on new ground the last of May. They produced a small amount of marketable pods by the last of August.

Carrots—Early Forcing, and parsnips—Hollow Crown, were seeded on new ground in the middle of April and produced marketable roots by the middle of August.

In some private gardens, on old, rich soil, the results were very much better than on the station ground, both parsnips and carrots attaining the size of 3 inches in diameter in some cases.

Onions—Red Wethersfield were not a success on new ground, the onions not being much larger than marbles, but on old ground they attained a size of from 2½ to 3 inches in diameter.

Beets—Early Egyptian were quite successful the past season, both on old and new ground, some beet roots measuring upward of 4 inches in diameter.

Turnips, ruta-bagas, radishes, and lettuce were all grown successfully.

Asparagus—Conover Colossal. Several short rows of this variety were seeded early in May, and a number of young plants were raised. It remains to be seen how well they will winter.

NURSERY STOCK.

A small beginning was made at the Sitka Station in establishing a nursery. Some 500 currant bushes have been raised from cuttings. A few dozen gooseberry and several hundred red raspberry plants were set out the past season. All of these are doing well.

The following varieties of grapes, about 25 plants of each, were sent to the station from the Department of Agriculture and planted out in nursery rows, and all made a moderate growth during the summer: Cottage, Catawba, Moyer, Salem, Martha, and Hartford. Of the blackberries, Snyder and Taylor were also received from the Department, and they likewise made a moderate growth during the summer.

A small collection of hardy ornamental shrubs were obtained from Nelson, Manitoba, and all of these have done well. The list includes the following: *Rosa rugosa*, Virginia creeper, English ivy, Boston ivy (*Vitis veitchi*), *Lonicera alba rosea*, *Lonicera splendens*, *Lonicera gracilis*, Siberian wild olive, and sand cherry; also a few small trees of *Pyrus baccata*, and of apples, Hyslop, Transcendent, and Hibernal.

Of strawberries, from 25 to 50 plants of each of the following varieties were sent to the station from the Department of Agriculture: Saunders, Haverland, Enhance, Excelsior, Bismarck, Lady Thompson, Bubach, New York, Gladstone, and Brandywine. Many of the plants were dead when they arrived, owing to the length of time they had been in transit, but a few were saved of each variety. One hundred and fifty native Alaska strawberry plants were obtained from Yakutat, where they grow in great abundance. These have been set out with a view to use them for experimentation. This native strawberry is very hardy, and it produces, under favorable conditions, berries as large as the end of one's thumb. Doubtless these can be used to cross-fertilize other varieties, with a view to producing new varieties from the seed.

It is contemplated to procure a small collection of hardy fruit trees the coming spring.

FLOWERS.

A number of hardy annuals were seeded, nearly all of which grew well and bloomed profusely. It is an interesting commentary on the climate of southeastern Alaska to note that the following were in bloom October 25 of the present year, viz: Asters, pansies, wallflowers, mignonette, sweet alyssum, candytuft, marigold, collinsia, sweet peas, dwarf german stock, leptosiphon, *Linum grandiflorum*, *Phlox drummondii*, and nasturtiums. Carnation plants were raised from seed, sown in the open.

Among the sweet herbs, mint and sage grow luxuriantly in southeastern Alaska.

WORK ON BUILDINGS.

As already intimated, the headquarters building is in a fair way to be completed this winter. The accompanying illustration (Pl. IX, fig. 2) shows the appearance of the building after the porch was completed and the stone foundation put under the house. The work which has been done inside consists in building the stairway from the first to

second story and finishing the two rooms facing the front on the second story, the laying of the floor in the attic, and cutting away a portion of the solid rock under the house so as to enlarge the cellar for a heating plant. There still remain two rooms to be finished on the second floor, a railing to be put on top of the house, and a roof to be built over the tank in which is collected the rain water which supplies the house, and also the installation of a heating plant. All this will be done the coming winter and the building will then be completed. It is a substantial structure well adapted for the purpose for which it is esigned.

The cottage on the farm (Pl. X, fig. 1) has been improved since the last report was written by the addition of a porch in the front and a small kitchen at the rear. When it is papered inside and the open space underneath boarded up this little building will also be completed.

A blacksmith shop (shown to the left in Pl. X, fig. 1) has been built since the last report was issued. It is a much-needed addition to the station equipment, as there is no blacksmith shop in the town, and we have had to do all repairs ourselves.

The station barn (Pl. X, fig. 2) has been improved by the addition of a seed room, the extension of the roof so as to cover the silo, and by enlarging the silo itself, so as to increase its capacity by about 40 per cent. A floor has also been laid in the attic of the barn, which increases the room for storage materially. When the structure is painted, the barnyard graded, and the immediate surroundings made more presentable this part of the equipment will also be completed.

CLEARING OF LAND AND DRAINAGE.

It rained so persistently nearly the entire summer that it was impossible to grub stumps to advantage. Only about one-half an acre has been cleared, but considerable work has been done in the way of draining the land already cleared. Unless the ground is thoroughly underdrained it can not be cultivated successfully. Pl. XI, fig. 1, shows a view of a portion of a tract of swamp land which has been cleared and drained. The process which we have adopted for underdraining the land on the Sitka Station was described with some detail in my last report. Briefly, it consists of building a conduit of slabs (the outer cuts from saw logs) in the bottom of the ditch in the form of a capital letter "A," and on the top of this conduit we pack brush and finally sod and then fill up the ditch with earth. Another year's experience with these drains has demonstrated their value. They work as satisfactorily as tile drains, and they are built of material which the pioneer can procure at little or no cost except that represented by his labor.

The entire reservation on which the Sitka Station is located was once a dense spruce forest. The timber was cut down by the Russians perhaps seventy-five years ago, but the stumps remain and in many places

FIG. 1.—ALASKA STATIONS—COTTAGE AND BLACKSMITH SHOP, STATION FARM, SITKA.

FIG. 2.—ALASKA STATIONS—STATION BARN (ROOF COVERING THE SILO), SITKA.

FIG. 1.—ALASKA STATIONS—CLEARED AND DRAINED SWAMP LAND, SITKA.

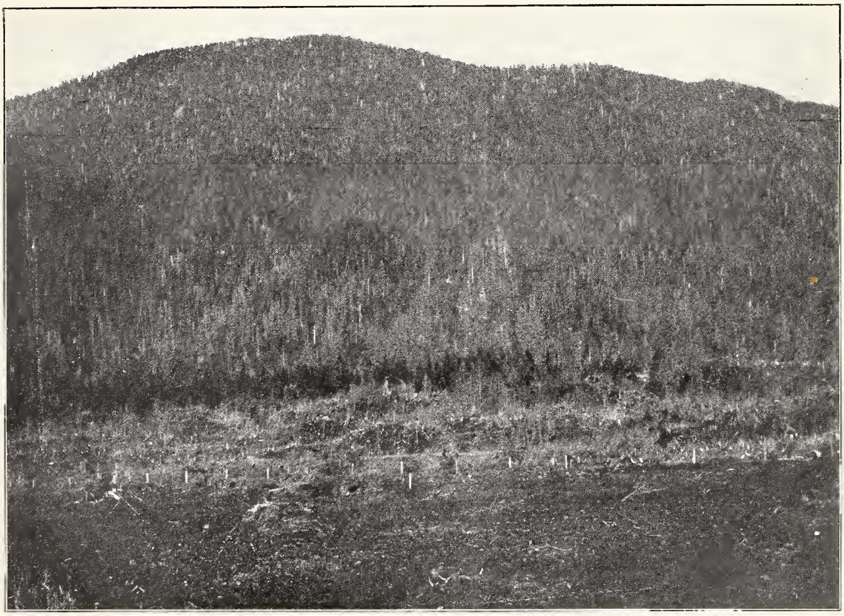


FIG. 2.—ALASKA STATIONS—PROPOSED EXTENSION OF SITKA STATION TO BASE OF MOUNTAIN.

also a more or less dense second growth. These stumps are thick on the ground, and the time and labor required to move them make clearing a formidable task. It is not proposed to clear a large area all at once, but rather to extend the clearing from year to year as the funds will permit and as more and more ground will be required by the growth of the work. Pl. XI, fig. 2, shows a view of a portion of the station reservation which it is proposed to clear in the near future. It comprises a succession of knolls and low ridges which it is believed can be made into good farm land when cleared and drained. The tract slopes toward the south, so that it is well exposed to the sun.

PRISON LABOR.

Since the law went into effect which permits prisoners in Alaska to be employed for a portion of their time on Government work, squads of from 2 to 8 or 10 prisoners have been detailed to work on the experiment station farm from time to time. While this labor has been a help, it can, of course, not be compared in efficiency to hired labor. A large proportion of the prisoners thus assigned have been Indians, who have never had any experience at farm work, and the same is true also of a portion of the white prisoners. Deducting time taken up in going to and from the prison morning and evening and at noon in going home to lunch, they rarely put in more than five hours' work a day.

It is, of course, not to be expected that compulsory labor of this character should be as effective as labor paid $2 per day. Such as it is, the assistance to the station of this prison labor has its value. What is done by the prisoners in this way saves a certain amount of hired labor.

WORK AT KENAI STATION.

Mr. H. P. Nielsen, superintendent of the Kenai Station, deserves much credit for the large amount of work he has accomplished. In addition to the cultivation of about 7 acres in many kinds of experimental crops and vegetables, he has cleared, broken, and put in condition for spring seeding about 8 acres of new land. For all this work he has only had one man hired by the month, and for a few days occasionally one or two native laborers. The timber he has cleared was not heavy, the trees running from 6 inches to 1 foot in diameter, but they stood thick on the ground. He works hard, faithfully, and intelligently.

The results at Kenai Station for the current season are, on the whole, quite satisfactory. Especially is this true of the vegetables. Cabbage, cauliflower, turnips, ruta-bagas, and in short all the leading hardy vegetables did well. Of the grains, barley and oats matured. The spring wheat did not mature this year, and rye and winter wheat seeded in the fall of 1901 were winterkilled.

A small beginning has been made with experiments in the line of animal husbandry by the purchase of a cow and a heifer calf. This cow has been fed exclusively on native feed, without grain of any kind; still her milk yield has been so large as to be creditable to a good dairy cow anywhere in the States. The yield is given in detail in Mr. Nielsen's report (see page 254).

The log house which constitutes the station building has been completed. A small log barn, which was built in 1899 to furnish shelter for the oxen and the few implements we then had, is now too small for our needs and additional barn room must be provided. I have authorized Mr. Nielsen to purchase the lumber in a building belonging to a cannery at Kenai, which is now closed. It can be bought for $100, and as the lumber it contains is sound and ample for our needs, I authorized him to close the bargain. The building was 75 feet long and 25 feet wide, and had a shingle roof in good condition.

The coming year we shall have 15 acres under culture at this station. This will enable us to gradually extend the area seeded to grain and also to experiment with forage crops on a more extensive scale than heretofore.

I respectfully recommend that as soon as it may be practicable a few more head of cattle be procured for this station and that our experiments then be extended on the lines of dairying and the production of beef.

It is the plan to continue the clearing of land each season until the cultivated land shall approach 100 acres in extent. But until the stations at Copper Center and Rampart are put on a working basis, it will scarcely be practicable to make large expenditures at Kenai.

A detailed report by Mr. Nielsen follows.

REPORT OF H. P. NIELSEN, SUPERINTENDENT OF KENAI EXPERIMENT STATION.

KENAI, ALASKA, *October 16, 1902.*

DEAR SIR: I herewith submit the report of the season's work for 1902.

CLEARING.

In addition to work with the experimental crops on the 7 acres previously broken, 8 acres have been cleared of trees, stumps, and brush, broken, and put in condition for seeding next spring, and the whole clearing has been fenced.

GENERAL IMPROVEMENTS.

Several improvements have been made, mostly in the line of additions to equipment. A 10-shoe press drill was added last spring, and was used in seeding all the field grains. Drilling is a great improvement over broadcasting, owing to the loose character of the soil. A

seed cleaner has been added this fall, and will be used in cleaning this season's crops. The log house on the station has been completed and is now quite comfortable. A milch cow and a calf were added to the station herd in July. The cattle now belonging to the station consist of 2 work oxen, 1 yearling steer, 1 cow, and 1 4½-months old heifer calf. The stable has been rebuilt to accommodate all of the stock. A corral has been built adjoining the stable.

About 5 tons of native grass was cut and cured and stacked in July and about half of it has been brought home.

A small orchard was set out last spring, consisting of several varieties of apple, cherry, and plum trees, raspberry, blackberry, gooseberry, and currant bushes, and 100 strawberry plants. Six of the 8 apple trees set out have done fairly well. Three of the 8 plum trees are now alive. Seven of the 10 cherry trees have made some growth, and 2 of these have done very well. Of one variety of raspberries all of the 6 plants set out have grown, and 2 of them ripened several berries. Of the Superlative raspberries 2 of the 6 plants grew, but did not bear. Six plants each of 2 varieties of blackberries were set out, and there is 1 survivor of each variety. About one-third of the strawberry plants grew, and have done remarkably well. That so many of the trees planted failed to grow I think was due to the length of their transportation, many of them being quite dry when they arrived.

The grain has been hauled off the field, and the portion which was dry enough to stack has been stacked up and the rest set in shocks to dry in the stack yard. The stubble has been plowed and disked and is in condition for seeding next spring.

NOTES ON VEGETABLES.

A cold frame was prepared and seeded April 26 to the following vegetables, viz, cabbage, cauliflower, Brussels sprouts, celery, lettuce, parsley, onions, and radishes.

Cabbage—Early Jersey Wakefield.—Came up in 6 days, and the plants were transplanted to the open ground June 5. The ground was prepared in the same manner as for the grain. It was given a dressing of fish guano at the rate of 400 pounds to the acre and worked with the disk and smoothing harrow. They were watered frequently during June, and did very well, many of the heads weighing from 3 to 5 pounds. The first head was cut about the middle of August.

Cauliflower—Early Snowball and Extra Early Paris.—Both varieties came up in the cold frame in from 7 to 8 days, and were transplanted to the open ground June 5 and 6. They were watered frequently during the month of June, but did not do very well. Only a few attained an average size. They seemed to need richer ground.

Brussels sprouts—Improved Dwarf.—Came up in the cold frame in 6 days and were transplanted to the open ground June 14. All the

plants have done well, but only about 10 per cent have set any sprouts.

Celery—Fin de siècle.—Began to show above ground in about 5 weeks, but did not get large enough to transplant. The largest plants only grew to be 2 inches high.

Lettuce—Large Boston Market and Early Curled Simpson.—Both kinds came up in the cold frame in from 10 to 12 days, and some plants of each kind were transplanted to the open ground June 7. They were watered frequently during the month of June, and made fine heads, especially the Boston Market.

Parsley—Extra Curled.—Began to show above ground in the cold frame in about 3 weeks, and as the other plants were taken out, it had plenty of room, and was left in the cold frame. It grew remarkably well and is about 10 inches high, green, and handsome.

Onions—Red Wethersfield.—The plants came up in the cold frame in about 2 weeks, and some of them were transplanted to the open ground June 21. The largest reached a size of about 1 inch in diameter, while others did not get larger than marbles.

Planted in the open ground May 13, the following: Peas, beets, carrots, and parsnips.

Peas.—The Alaska peas came up in from 16 to 18 days. On July 15 they were from 8 to 10 inches high and in bloom. We had our first mess of peas from them August 10, but might have had them a week earlier. The vines grew to a length of 3 feet, and kept blooming and setting pods till the last of September. American Wonder came up in from 16 to 18 days. On July 1 they were 4 to 6 inches high and in bloom. They had eatable peas on them August 1. Some of the vines reached a height of 15 to 18 inches, but most of them only averaged 10 inches, and were covered with pods.

Beets—Egyptian, did not come up for a month and made little growth. None of them reached an eatable size. They were a failure this year.

Carrots—Half-long Chantenay, came up in about 3 weeks and did well, some of the largest roots being 4 inches long and 2½ inches in diameter.

Parsnips—Hollow Crown, came up in 3 weeks and did fairly well, some of the largest being 6 inches long and an inch in diameter.

Mustard—White London, planted May 26, came up in a few days, and on July 1 was 10 inches high. We began using the leaves for greens soon after that. It began blooming about the middle of the month, but none of it was allowed to go to seed.

Spinach—Savoy, was planted May 26, came up in two weeks, and went to seed. It did not grow any leaves at all.

Garden Cress was planted May 26, came up in ten days, and made excellent greens all summer.

Asparagus—Conover Colossal.—A small bed was liberally manured and spaded deep and planted to asparagus seed May 26. The plants

have made a growth of from 4 to 6 inches, but I can not say whether they will winter.

Rhubarb—Linnæus and Victoria.—No rhubarb was planted this year, as all the plants from last year wintered over and did wonderfully well this season. We used all we could and supplied half the village with rhubarb all summer from two dozen plants.

Ruta-bagas were seeded in rows 18 inches apart on May 22, and cultivated frequently during the summer. None of the roots grew exceptionally large, but quite a number weighed 3 to 4 pounds each.

Turnips— White Dutch.—Sowed broadcast June 2 and covered with the garden rake. They did remarkably well. Some of them weighed 8 pounds each.

Potatoes—Early Rose, planted May 23 and 24. On July 1 they were from 3 to 5 inches high; stand good. On July 15 they were 6 to 12 inches high and growing very fast. On August 1 they were 12 to 18 inches high and beginning to bloom. August 15, tops about the same and in full bloom. The tops were still green up to September 24, when they were killed by the frost. They were dug soon after. About 80 per cent were marketable and many of them weighed a pound each.

NOTES ON FIELD CROPS.

Winter Grain and Forage Plants.

Excelsior Winter Rye, seeded August 2, 1901; Hybrid Wheat, from Minnesota Experiment Station, seeded August 2, 1901; Sandomer and Yarasloff Winter Wheat, seeded August 15, all winterkilled.

The Red and Alsike clover, seeded May 23, 1901, winterkilled. The flat pea seeded May 30, 1900, winterkilled last year.

Spring Crops.

WHEAT.

Romanow wheat was seeded on old ground May 29 and on new ground June 2. Both plats came up in about ten days. On July 1 its condition on old ground was as follows: Stand and color good, 5 inches in height. On new ground stand good, but growth spindling, 5 inches high. July 15, on old ground growth uniform, 12 inches high; on new ground stand good, 12 inches high. August 1, on old ground 2½ feet high, fully headed, stand uniform; on new ground fully headed, 27 to 30 inches high. August 15, on old ground 3 feet high and in bloom; on new ground 3½ to 4 feet high and in bloom. September 1, on old ground about 30 per cent of heads filling, the rest still in bloom, a few heads with chaff turning brown, straw still green, shows no signs of ripening; on new ground the same conditions existing. September 15, on old ground straw still green, a few heads turning brown, will not mature any seed; on new ground large heads and rank

straw, but no grain; straw green, chaff turning brown. Both plats were cut October 4. The frost turned the chaff brown and the straw white, but there was practically no grain in the heads.

BARLEY.

Manshury.—Seeded 1 acre May 28 on old ground. A small plat seeded on new ground June 2. July 1, conditions on old ground, stand good and uniform, color good, 4 inches high; on new ground the same. July 15, on old ground spotted, average height 9 inches, no heads; on new ground uniform stand, 16 inches, no heads. August 1, on old ground fully headed, 50 per cent in bloom, average height 30 inches; on new ground headed, in bloom, 3 feet high, excellent stand. August 15, on old ground average height 3½ feet, past the bloom, about 50 per cent in the milk; on new ground 5 feet high, about 50 per cent in dough, promising well. September 1, on old ground most of it in the dough, about 10 per cent of heads and straw turning yellow; on new ground 50 per cent of straw and heads turning yellow, the rest green, with grain in dough. September 15, on old ground half of it practically ripe, straw green, the rest with grain in the dough. The grain in the ripe heads still soft owing to the persistent wet weather. Half the plat on the new ground was cradled, bundled, and shocked September 22; the rest was cut October 4. It is thoroughly ripe, and has fine large heads and grain. The plat on old ground was cut October 3, and there was some green straw in patches, but about 90 per cent of it is ripe.

OATS.

Burt Extra Early.—Seeded on old ground May 29, and on new ground June 2. On July 1 its condition on old ground was as follows: Stand good, 3 inches high. On new ground stand good, and uniform, 3 to 4 inches high. July 15, on old ground 10 inches high. On new ground 14 inches high. August 1, on old ground, in bloom, 27 inches high, very promising. On new ground, fully headed, 30 inches high. August 15, on old ground 30 inches high, about 50 per cent in the milk. On new ground 40 inches high, 50 per cent in the milk. September 1, on old ground chaff on about 10 per cent of heads, turning yellow, straw green, and the rest in milk. On new ground few heads with grain in the dough, straw green, most of it in the milk. September 15, on old ground about 20 per cent of heads turning yellow, straw green, ripening very slowly. On new ground 10 per cent of heads turned yellow, straw green. Both plats were cut October 6. When cut there was about 30 per cent of it with firm grain. Some of the straw had turned yellow, but the field looked green at a distance.

Tobolsk.—Seeded May 29 on old ground. It came up in 10 days. July 1, stand and color good, looks promising, 4 inches high. July

15, 10 inches high, stand excellent. August 1, fully headed, uniformly 26 inches high. August 15, 75 per cent in milk, 3 feet high. September 1, a few heads with grain in the dough. September 15, about 10 per cent of heads turning yellow, straw all green, the grain in milk and dough. When cut October 7 the chaff on all the heads was turned white from frost, most of the straw green. Will make a little seed.

St. Petersburg.—Seeded May 29. On July 1 it was 4 inches high, with a good uniform stand. July 15, 10 inches high. August 1, about 75 per cent headed, 27 inches high. August 15, 3 feet high, past the bloom. September 1, in the milk. September 15, green yet, grain in the milk and dough. When cut, October 7, grain still soft and straw green. Will not make any seed.

Banner.—Seeded May 29. On July 1 it was noted there was an excellent stand 4 inches high. July 15, 9 inches high. August 1, just heading, 2 feet high. August 15, 3 feet high, some in bloom and some just past. September 1, straw dark green, grain in the milk. September 15, straw green, grain in the milk and dough. When cut, October 4, the straw was green and no seed ripe. It evidently will not mature here.

Common field oats.—Sown for hay at the rate of 2½ bushels per acre on June 14. On July 1, stand good, 3 inches high. July 15, 6 inches high. August 1, stand excellent, 1 foot high. August 15, 18 inches high, heading out. September 1, 3 feet high, fully headed and some in bloom. September 15, some headed, with grain in the milk; most containing no seed. It was cradled and bound in small bundles. October 3 and 4, straw and leaves still green. In places it was beaten down badly by wind and rain. Some of it in the milk, but most of the heads were empty.

BUCKWHEAT.

Orenburg.—Seeded May 28. On July 1 it was 2 to 3 inches high, with a fair stand. July 15, growth uneven, 2 to 8 inches high, rank stalks, coming into bloom. August 1, still growing, uneven, average height 18 inches, in full bloom. August 15, average height 2 feet, forming seed and blooming. September 1, in all stages from bloom to ripe seed. September 15, showed about 40 per cent ripe seed, a few blossoms yet. It was killed by the frost September 24. It was cut September 25, gathered up and spread out in the shed to dry. It showed about 50 per cent ripe seed.

FLAX.

Riga.—Sowed thick for fiber. Seeded on June 2 on new ground. July 1, stand good, 2 to 3 inches high. July 15, stand excellent, 8 to 10 inches high. August 1, average height 16 inches, about 10 per cent in bloom. August 15, average height 2 feet, almost through

blooming, well set with seed pods. September 1, a few blossoms still present, about 10 per cent of seed pods turning black. September 15, gone out of bloom, still green, seed pods turning black. The frost of September 23, 24, and 25 turned it all black. Pulled October 8. Only about 15 per cent of the seed ripe.

GRASSES.

Perennial rye grass.—Seeded June 4, in rows about 8 inches apart, and seed covered about 1 inch deep. August 1, stand good, 4 inches high. August 15, stand excellent, 6 inches high. September 1, 10 inches high, and showing a few seed stalks. September 15, spreading out, and has completely covered the ground. It was cut and fed to the calf September 23. The plat is green at this writing, but shows very little growth.

Orchard grass.—Seeded June 4 in rows, the same as the foregoing variety. August 1, stand excellent, 5 inches high. August 15, 8 inches high. September 1, 12 inches high. September 15, 14 to 16 inches high. It was cut for hay September 25. It made excellent hay, but showed no sign of heads.

Redtop.—Seeded June 4, same as the foregoing. August 1, stand fair, 4 to 6 inches high. August 15, 6 to 10 inches high, beginning to stem. September 1, average 12 inches high, showing a few heads. September 15, average height 16 inches and about 60 per cent headed. Cut for hay September 25. No seed had formed. Stubble still green and growing a little.

Meadow foxtail.—Seeded June 4. August 1, stand good, 6 inches high. August 15, 8 to 10 inches high and beginning to stem. September 1, most of it 12 inches high, a few seed stalks headed out. September 15, the bulk of it has not grown any. A few more seed stalks and heads in bloom. Cut for hay September 26. Stubble still green.

Timothy.—Seeded June 4. August 1, stand excellent, average 7 inches high, heading out. August 15, average height 12 inches and 50 per cent headed, early heads in bloom. September 1, 2 feet high, fully headed. September 15, 27 inches high, about 20 per cent gone out of bloom, rest in bloom. Cut for hay September 25. No seed; stubble still green and growing.

Smooth brome grass.—Seeded June 4. August 1, stand excellent, 7 inches high. August 15, 10 to 12 inches high, beginning to stem. September 1, 18 inches high, no heads. September 15, has not grown much. Cut for hay September 25. Stubble shows yellow.

Tall meadow oat grass.—Seeded June 4. August 1, stand excellent, 12 inches high. August 15, average height 18 inches. September 1, 30 inches high, 10 per cent headed. September 15, still green, has not grown mu h. Cut for hay September 25. Stubble shows yellow.

Tall meadow fescue.—Seeded June 4. August 1, it stands good, 4 inches high. August 15, 6 inches high. September 1, 6 to 8 inches high, no stems yet. September 15, still green, but has not grown much. It was cut September 26, but made very little hay.

Blue grass.—Seeded June 4. August 1, medium stand, 2 inches high. August 15, 3 inches high. September 1, 4 inches high, not growing much. September 15, 5 to 6 inches high, spreading out. It is still green, but not growing any.

Furze.—Seeded June 4. August 1, just showing above ground. August 15, not growing much; some of it is an inch high and some just coming up. September 1, not growing any. September 15, average height 2 to 3 inches. A few stems 7 to 8 inches high; poor stand.

Polygonum sachalinense.—Seeded June 9, in rows 2 feet apart. The seed was covered about an inch deep. August 1, poor stand, just showing above ground. August 15, not growing much. October 12, the largest of the few plants that did come up only reached a height of 2 to 3 inches; some did not grow at all after coming up. The leaves are still green.

RAPE.

Dwarf Essex.—Seeded June 11 in rows 2 inches apart and the seed covered an inch deep. July 12, coming up. August 1, now apparent that it was sowed entirely too thick; 8 to 10 inches high. The two outside rows show green and vigorous; the rest looks sick. August 15, inside rows 10 inches high, outside rows 2 feet high. September 1, inside rows setting seed and stalks, some of them in bloom; the two outside rows 30 inches high. September 15, no material difference from previous date. Began soiling and feeding cow with it September 20. Early cutting growing up again.

HEMP.

Seeded June 4 in rows 8 inches apart and seed covered an inch deep. August 1, growing uneven, stand good, average height 12 inches. August 15, the growth uneven, average 18 inches high. September 1, average height 30 inches; in the bud. Buds and top leaves nipped by frost August 31. September 15, has not grown any, will not make any seed. September 1, average height 30 inches. A few stalks were over 5 feet high. Possibly with an earlier seeding and the rows wide enough apart to admit cultivation it would do well.

MILK RECORD OF COW "BOURKA" FOR JUNE, JULY, AND AUGUST, 1902.

FEED—NATIVE PASTURE.

Dropped heifer calf June 2; calf suckled until evening of June 5, from which date the milk was weighed.

Milk record for June, July, and August.

June.		July.		August.	
Date.	Weight.	Date.	Weight.	Date.	Weight.
	Pounds.		*Pounds.*		*Pounds.*
6	28.5	1	31.0	1	26.5
7	32.0	2	32.0	2	26.5
8	33.5	3	30.5	3	29.0
9	34.5	4	32.0	4	27.5
10	27.0	5	30.5	5	27.5
11	31.5	6	29.0	6	26.0
12	28.0	7	29.0	7	28.5
13	33.0	8	28.5	8	28.5
14	32.0	9	31.5	9	27.5
15	35.0	10	28.0	10	26.5
16	30.0	11	29.5	11	28.5
17	31.0	12	30.5	12	27.5
18	30.5	13	29.5	13	29.0
19	31.0	14	30.0	14	24.0
20	30.5	15	30.0	15	31.5
21	30.0	16	28.0	16	26.5
22	32.5	17	27.5	17	29.0
23	28.5	18	29.5	18	28.0
24	33.0	19	28.5	19	28.0
25	30.0	20	28.5	20	27.0
26	31.0	21	26.5	21	28.5
27	31.5	22	28.5	22	27.5
28	30.0	23	29.0	23	28.0
29	30.0	24	27.5	24	28.0
30	30.0	25	28.5	25	27.5
		26	28.0	26	28.5
		27	29.5	27	27.5
		28	27.0	28	27.5
		29	27.0	29	29.0
		30	23.5	30	28.0
		31	25.5	31	28.0
Total for 25 days.	775.0	Total for July..	894.0	Total for August.	861.0

Total yield for eighty-seven days was 2,530 pounds, or something over 29 pounds a day, on native grass only. Many a dairy cow in the States fed on clover and grain does not do better than this. This would indicate that successful dairying can be practiced on Kenai Peninsula.

Respectfully submitted.

H. P. Nielsen,
Superintendent, Kenai Experiment Station.

Prof. C. C. Georgeson,
Special Agent in Charge of Alaska Investigations.

WORK AT RAMPART STATION.

For want of funds but little work has been done at Rampart Station during the past year. As yet no one has been employed to take the place vacated by Mr. Isaac Jones in the fall of 1901. When Mr. Jones left, a resident of Rampart, Mr. J. W. Duncan, undertook to care for the property on the place, and also agreed to seed the ground Mr. Jones had cleared and cropped in 1901. Under date of June 11, 1902, Mr. Duncan reported that he had seeded the following grains: Winter rye, Romanow spring wheat, Ladoga spring wheat, Manshury barley, and oats of the following varieties: Flying Scotchman, Black Finnish, Burt Extra Early, and common oats; also some red clover and buckwheat. On October 31 I received word from him to the effect that

the summer had been pleasant and favorable to the growth of these grains, which had all matured, and he sent a few heads of each variety. The grain of all varieties was hard, plump, and perfectly matured.

The Romanow spring wheat is especially fine. The heads are large; the grain is plump, hard, and perfectly matured. Ladoga spring wheat has a little smaller head than the foregoing, but the grain is equally plump and perfectly matured.

The winter rye was raised from seed grown at the Rampart Station in 1901. I mentioned in my last report that this rye matured perfectly. It has again lived through the winter and matured fine grain, although the heads are short.

Manshury barley has likewise matured perfectly this season. In my report for 1901 I stated that it had ripened that year by the middle of August. The present small crop was raised from last year's crop.

Of the four varieties of oats grown, the Black Finnish is especially fine. The grains are large, plump, and heavy, and perfectly ripe.

Burt Extra Early oats is likewise a good sample, although both heads and grains are small—characteristics peculiar to the variety.

The Flying Scotchman is a variety not especially distinguished for its earliness, but it has matured plump, heavy seed.

Common oats, such as are sold for feed in the country, also matured. That these oats, which were grown for the most part in Washington and Oregon, should mature up there is, perhaps, the most convincing test of the agricultural possibilities of the country.

When we consider that Rampart Station is located in 65° 30′ north latitude, the fact that all these varieties have matured ought to be convincing proof that the country is capable of sustaining an agricultural population, and that the vast region south of the Yukon is well worth developing.

I recommend that the Rampart Station be equipped with implements, buildings, and a competent superintendent, and that the work of experimentation there be undertaken on a farm scale.

EXPERIMENTS ON WOOD ISLAND.

By an arrangement with Rev. Curtis P. Coe, superintendent of the Baptist Orphanage on Wood Island, a series of experiments with grains and vegetables was carried on the past season, a report on which, by Mr. Coe, is submitted herewith. In 1898 a reservation was made on Kadiak Island for an experiment station; but never having had sufficient funds to equip this station, but little work has been done there. Mr. Coe's proposition to cooperate with the experiment station in his farm work at the orphanage was therefore willingly accepted.

Mr. Coe has met with conspicuous success in nearly all of his farm and garden operations, and for the coming year he is equipped to do still better work and on a larger scale than heretofore. He has a herd

of four dairy cows, which have yielded a good supply of milk, on native feed, and as regards the adaptation of the country for the production of beef he found that one steer netted in meat and hide $110, a cow $82, and a yearling steer $60.

He has acquired a small flock of Angora goats, with a view to experiment on their adaptability to the country and the available feed. He has been very successful with ducks and with a flock of Black Langshan hens.

Mr. Coe matured successfully the past season winter rye, Romanow spring wheat, Manshury barley, Black Finnish and Burt Extra Early oats, spelt, seed from Dwarf Essex rape, and he has made a good start in the leading kinds of grasses and clover. Some of his cabbage weighed 9 pounds and cauliflower 6 pounds, and carrots, parsnips, peas, beets, mustard, turnips, ruta-bagas and horse-radish were all successful. The failures were Jerusalem artichokes, buckwheat, *Polygonum sachalinense*, and celery, and onions were but a moderate success. If all these things can be grown on Wood Island it seems almost certain that they can also be grown on any of the islands along the western coast of Alaska.

REPORT OF REV. C. P. COE ON EXPERIMENTS AT KADIAK BAPTIST ORPHANAGE ON WOOD ISLAND.

KADIAK BAPTIST ORPHANAGE, WOOD ISLAND,
Kadiak, Alaska, October 20, 1902.

DEAR SIR: I have the honor to submit the following report of the agricultural experiments conducted at the Kadiak Baptist Orphanage the past year:

Plat A is a small house garden in a clearing. It has been used for five years. The last year it lay fallow. It was fertilized with barn manure, which was spaded under and a light dressing of fish guano was sown over the top before making the beds and raking. The soil is black sandy, with considerable humus.

May 25 Sir Walter Raleigh potatoes and Jerusalem artichokes were planted, and June 3 turnips and ruta-bagas were sown. The luxuriant growth tempted a cow through the barbed wire, and all the tops, except the artichokes, were eaten. I was surprised, however, to find a good yield of potatoes in September.

Plat B is near an old house which was last used for a stable. It was first broken last fall. Soil is deep and rich, but in some places very rocky. Stable manure and a slight dressing of fish guano were applied. June 2 a plat of 2 square rods was planted to potatoes, which produced 4 bushels. Artichokes did no good; tops grew 4 feet high. June 10 a few square rods of Right Side oats were planted. These produced a large amount of heavy straw; long, heavy heads. The grain was

badly trampled by dogs, but at least 2 bushels of seed were saved, the straw being put in the silo.

Plat C is an old garden, black sandy soil, oats last year, fertilized with barn manure, rotted silage, and codfish heads and backs. Planted to potatoes May 12 and 18. Cultivated flat with horses and hoes. The plat, which contained nineteen thirty-seconds of an acre, produced 170 bushels of fine, large potatoes, but some were hollow and rotted inside. The seed was native-grown Early Rose. Radishes, turnips, and rutabagas planted in the same field gave large yields. Onions, parsnips, and carrots did not germinate, owing to dry weather, probably.

Plat D, garden in use nine years and highly fertilized every year. Kelp and barn manure used in the spring. April 29, peas were planted. Began yielding in June and continued until September. May 10 two beds of potatoes were planted, 300 feet of rows, which yielded 10 bushels, being nearly 600 bushels to the acre. Hemp was sown in drill, grew to 6 feet high, in some cases; but few seed germinated. June 3 onion multipliers were set out and did well. Same date cabbage and cauliflower, which had been raised in a window box, and later transplanted into tin cans, were set out with whole clod of dirt undisturbed. They grew quickly and well and produced cabbage heads weighing 6 to 9 pounds, and cauliflower weighing as much as 6 pounds. This way of raising plants pays for the extra trouble. June 10 seed of ash, hemlock, white birch, white pine, and red cedar were planted in very rich ground, but failed to germinate. Celery was set out June 15. Fish guano was sown in the trenches and one or two applications given later, but plants did not do well. Plants have been taken up and set very closely in boxes in a damp cellar, where they are making good growth. Buckwheat was sown in drills June 25 and grew well, blossomed, but did not mature. A very slight early frost in September nipped the tip off the plants. In this same garden we have 100 rhubarb plants that furnished good-sized stalks from May to September. Some currant bushes had a few bunches of fruit. Horse-radish made a good growth.

Plat E is a small garden which has been used ten years. It has been well manured. This year a liberal amount of barn manure was used and spaded deeply. Soil black sandy and dry. April 28 carrots, beets, parsnips, radishes, lettuce, spinach, Broad Windsor beans, parsley, turnips, and peas were sown in drills in beds. Spinach and parsley did no good. Beets did better than we have ever had them do here before, but that is saying little. Beans grew tall and bore pods which are now well filled, but not mature. The other vegetables did well. Cabbage and kale set out in June yielded large heads. The late cabbage, if planted early, makes better and larger heads than the early varieties. Hereafter I shall use Flat Dutch or a similar variety for the principal crop.

Plat F is a small garden two years in use. Soil is chocolate loam. Steep southeast hillside, fertilized with barn manure. April 18, 19, 21, and 22 peas, carrots, lettuce, mustard, parsnips, parsley, radishes, turnips, ruta-bagas, and beets were sown in drills. All did very well. On April 26 and 28 other rows of the same seeds were sown. There was no difference in results. June 25 one row of *Polygonum sachalinense* was sown, with no results. All cultivated fat.

Plat G is a southeast hillside, chocolate soil, in use three years. Was fertilized with rotted sod and a liberal dressing of fish guano. May 12, rape was sown; June 9, radishes and winter radishes were planted; June 12, a bed of *Polygonum sacha inense*, and June 22, cabbage, kale, celery, and cauliflower plants were set. Later spaces were filled with ruta-baga plants. Everything in the garden did well except the Polygonum and celery. One head of the 1,000-headed kale weighed 9 pounds, one stalk of rape 6 pounds. Winter radishes were planted too soon, grew large, and burst open. A small patch of rye had been sown last fall. The stand was poor, but the straw was tall and the heads heavy. It did not mature until September.

Plat H is a field of deep black sand near the beach. April 22, 20 plats were prepared by sowing on each 100 square feet about 50 pounds of decayed shellfish, brought from an island a mile distant, which was harrowed in deeply. The ground was not plowed, as it was loose and easily harrowed. This was a mistake, however, as the weeds had no serious setback. On this ground 200 square feet of each of the following was sown April 22: Ruta-bagas, wheat, orchard grass, perennial rye grass, tall oat grass, meadow foxtail, tall fescue, blue grass, redtop, smooth brome grass, white clover, red clover, alsike clover, barley, furze, Black Finnish oats, rape, *Poa aquatica*, and hemp. Not one made a creditable showing.

Next to this the same amount of land was plowed and sown May 1. Lettuce, radishes, turnips, and rape did fairly well. Millet grew 6 inches in height.

Peas were tried on another plat of the same, but a strong hot wind blighted them so that the yield was very small. One small plat of grass, mixed seed, took a slight hold and may be all right another year. Smooth brome grass sown in May did not germinate. Potatoes planted May 10 and 18 gave a fair yield, but not nearly so great a yield as those noted above. For these barnyard manure was used in addition to the shellfish.

June 10 turnips, ruta-bagas, kale, giant spurry, furze, hemp, parsnips, and carrots were sown in drills in ground just plowed. A small amount of fish guano was sown on the ground after plowing and before harrowing. The turnips and ruta-bagas yielded very well. The giant spurry grew to about a foot high and was cut for hay. The rest was a failure. Giant spurry sown on newly plowed ground a week

later failed to make a showing until this fall. There is now a scattering stand. Polygonum also failed here. This field is infested with sorrel, which is hard to control in seed sown broadcast. In the potatoes it was no trouble, except where planted in the sand without plowing.

Plat I is a northwest slope, plowed for the first time last fall, and consists of about one-half acre. Soil heavy sod, sandy, black. Sod was too stiff to plow again in spring. Harrow and plank clod crusher were used thoroughly. A liberal dressing of fish guano was applied before harrowing the last few times. The field was divided into plats 20 feet square, and May 1 sown to grass seed as follows: Plats 1 and 2, rye grass; 3, white clover; 4 and 5, foxtail; 6 and 7, timothy; 8, alsike clover; 9 and 24, oat grass; 10 and 11, smooth brome grass; 12, red clover; 13 and 14, orchard grass; 15 and 16, blue grass; 17 and 32, red top. The rest of the 56 plats were sown to mixtures of grass seed, each two different from the rest, except two plats in a very wet corner, where *Poa aquatica* was sown alone. Every variety, whether alone or in mixture, did very well except the *Poa aquatica*, which made no show at all. The field was cut for hay in September. The clover was a surprise, as heretofore I have not had good results from it. Furze was sown along one edge of this field, but nothing which could be taken for the plant has been seen.

August 15, on a patch of ground in this field just plowed, a mixture of grass seed was sown. Rains immediately followed and now the grass shows a good stand. On August 23 one-third peck of Excelsior rye was also sown, and has made a fair start. October 4 one-sixth peck of rye was sown on the ground after potatoes had been removed.

Plat J is a southeast hillside, plowed first last fall. Too stiff to plow in spring. Harrowed several times. Moderate dressing of fish guano applied. Planted May 21 to rape broadcast, and giant spurry, 1,000-headed kale, Scotch kale, parsnips, carrots, Broad Windsor beans, Brussels sprouts, and turnips in drills. Turnips, ruta-bagas, rape, carrots for stock broadcast, and peas in drills. Brussels sprouts and Broad Windsor beans did no good, although both had fair tops. The rest of the vegetables did very well. From the small patches of turnips and ruta-bagas here and in plats H, C, and G, we had nearly 100 bushels of turnips and 50 bushels of ruta-bagas. Carrots were used through the summer, and a few bushels harvested this fall. Parsnips have been left in the ground. They are fair-sized, and there was a better yield than ever before. Furze sown in this plat failed to make a showing.

Plat K has been used two years. Plowed first in the spring of 1901, and planted to grain and potatoes. Plowed in the fall of 1901 and this spring again. The old sod was still much in evidence. The soil is dark, loamy, and slightly gravelly. April 30 the portion used for

grain last year was again sown to grain, as follows: 200 square feet Black Finnish oats, home-grown seed; 480 square feet home-grown Romanow wheat; 720 square feet barley, Wisconsin seed; 1,320 square feet Wisconsin oats; 960 square feet Romanow wheat, Government seed; 1,000 square feet Black Finnish oats, Government seed. Every plat did exceedingly well. The grain stood from 4 to 5 feet high, the heads were large and full, and all matured, although the home-grown Black Finnish oats were the latest to mature. They were cut October 10. Rape sown broadcast on the same plat was too thick and thinning out was injurious to it. It went to seed early and will furnish a large amount of seed. Hemp did not grow at all.

The grain has not been thrashed, but I will try to report this yield later on. It will be creditable, I am sure.

The portion in potatoes last year was again planted to potatoes, one-half in home-grown seed and the other in Wisconsin seed imported this year. The tubers were good size, smooth, and clean, but the yield was not large. In August the tops of the potatoes seemed to have been nipped with frost.

Jerusalem artichokes were a failure here as elsewhere. This may be accounted for by the fact that the tubers were cut in pieces before planting. They will be tried again next year and whole tubers will be planted.

Before the potatoes were out of this plat, on August 29, winter rye was sown between the rows. Excelsior and Giant rye were 2 inches high when the potatoes were dug, and at this time they and the Schlansted rye are looking very fine.

A small patch of timothy sown last year grew 2 feet high, and bore good heads of seed that ripened early. The stalks were well leaved out, and there is no doubt timothy will do well.

Plat L consists of a southeast slope and top of two hills, plowed first last fall. The sod was too heavy to plow again in the spring. Fish guano was applied after one or two harrowings, and harrowed in repeatedly. A harrow and a plank clod crusher and leveler were used after sowing. On this plat were sown, April 30, 1 bushel Marvel spring wheat, Wisconsin seed imported last year; Manshury barley, home grown, about one-half bushel, and 32 square rods of spelt, Wisconsin seed imported last year. These all grew well, forming straw 3 to 5 feet high, and the heads were well filled. The barley was cut September 10, the spelt September 25, and the wheat October 13. All grain was cradled.

Rape, turnips, and ruta-bagas were sown broadcast at the same time, and all did well, but were too thick to make the best returns. The rape was cut and put in the silo. The turnips and ruta-bagas were pulled and hauled to the silo, where the tops were cut off and used for silage, and the roots put in the root cellar.

May 20 Earliest Russian millet was sown, and a light dressing of fish guano again given the ground. The millet made slow growth, but looked healthy at all times. It grew to about 16 inches high, and was just forming heads when cut for hay, September 26. Repeated rains following immediately, it was finally put in the silo. This is the best millet we have raised in several attempts.

Plat M is a small garden in Plat L, used several years. In this were planted, April 30, Burt Extra Early oats, Manshury barley, rape, and hemp. The oats and barley did well, rape little, and hemp nothing at all.

Plat N is long and narrow, on a southeast hillside, surrounded with timber, and consists of about 9 acres, which have been plowed for the first time this fall. The sod is very tough and the whole was covered, when plowed, with much herbage, grass, ferns, etc.

On a portion of the first plowing one-third of a peck of Excelsior winter rye was sown August 25, and one-sixth of a peck of Giant rye October 3. The first sowing is looking well. I have not seen the other since planting.

Plat O is a marsh and extension of same which has been filled with sand blowing in. The sandy part was plowed August 2, and August 6 a small patch of alsike clover was sown. It has made a start, but does not promise well. Some grass seed was sown in the marshy part, but the results can not be told at this time.

I consider this year's work on the whole very successful. We raised about 250 bushels of potatoes, 100 bushels turnips, 50 bushels rutabagas, carrots, parsnips, cabbage, cauliflower, onions, kale, rhubarb, etc., in sufficient quantities to supply our family of 40 members and have considerable for sale. The grain in every particular surpassed my expectations, and we had rape, kale, and grass in the silo.

Artichokes and millet, and in some places peas, Giant spurry, carrots, parsnips, and celery, were failures. All the latter, however, I am convinced, were because of poor seed, or dry, hot weather, which we had in May and June.

It may be interesting also to know the progress of our live stock. We had 4 milch cows and raised 3 calves; the fourth one was premature. The cows were kept for milk. One of these, raised by us from a native cow, gave for about three months an average of 35 pounds of rich milk a day. The others gave a better quality of milk, but not so much. Our large family was supplied with milk and cream, and some butter was made besides. The cows received no feed, but ran in pasture. They continue to give good milk, but a less quantity.

From a flock of 30 hens we had eggs in good number, and raised over 100 chickens this summer. They are free from disease and grow well. They are Black Langshans, and 2 young roosters killed recently weighed, after killing, 4 pounds each.

I purchased 4 ducks in the spring, and besides using many of the eggs, raised 20 ducklings, which are now full grown. They did so well that I have recently purchased a half dozen large Pekin ducks at Seattle. Three ducks and a drake I will keep separate and 2 drakes I will put with the native ducks.

In August I received the 5 Angora goats I had ordered and they are doing well. Their fleeces at this time are long and glossy. They will find a great plenty of forage without diminishing the feed for cattle, but are somewhat difficult to confine within a fence.

Cattle that run all winter without feed do well. One steer, a native, 3½ years old, killed this summer, brought, in beef and skin, about $110. A cow 4 years old, which had been used for milk, and had raised a calf this year, when dressed brought $82. A steer 16 months old, which had been fed last winter, when dressed brought over $60.

This report would not be complete without mention of the success with flowers. We have not tried to raise a great variety, but have had abundant success with pansies, poppies, and sweet peas, besides hot-house plants.

The crab-apple trees spoken of last year continue to thrive.

Thanking you for your kind and hearty cooperation in the work here, I am,

Sincerely, CURTIS P. COE.

THE OPENING OF AN EXPERIMENT STATION IN THE COPPER RIVER VALLEY.

In accordance with the plans formulated last year we have taken preliminary steps for the opening and equipping of a station on the Copper River. All the information which we have collected in regard to the agricultural possibilities of that region of the interior was so favorable that it seemed to be imperative that work should be begun there. Mr. Jones's observations on the country last year proved that there are many thousand square miles in the valleys of the Copper, the Tanana, and the Fortymile which are adapted to agriculture and to grazing. We have reliable evidence that grain will mature there, and it is likewise known that live stock has lived through the winters without shelter. These facts strengthen the probabilities that agriculture can be made successful there.

The great drawback to the opening of a station in the interior is the difficulty of transporting the equipment and supplies. The military trail which has been completed by the Government from Valdez as far as the Tanana River, 265 miles distant, has made it possible, however, to carry goods inside, but transportation is still expensive. During

the summer season it costs 50 cents a pound to pack goods from Valdez to Copper Center, 103 miles from tide water. In the winter season, when sleds are used, packing will cost somewhat less. No regular price is established for the winter trail.

The plans for this work have been under consideration for a long time, but the execution of these plans began last April with the appointment of J. W. Neal, of California, to take charge of the work. Mr. Neal comes to us highly recommended by the authorities of the Agricultural Experiment Station of California, where he has been employed for some nine or ten years past. He reported for duty at Sitka on June 27 last, and a few days later, with F. E. Rader, the assistant at Sitka Station, started for the Copper River country, via Valdez, with a view to inaugurate the work.

When Mr. Isaac Jones made his reconnoissance in the fall of 1901, he was instructed to look out for a suitable location for an experiment station, and he recommended that a station be located in the neighborhood of Copper Center, near the junction of the Klutina with the Copper River. Messrs. Rader and Neal, after examination of the immediate neighborhood, confirmed this view, and they accordingly began work there.

A TEMPORARY RESERVATION.

With only a pocket compass to guide them, they ran lines about a quadrangle, which contains approximately 775 acres. They planted stakes at the corners and at intervals along the sides and marked these stakes "U. S. Experiment Station." I recommend that this tract be retained temporarily as an experiment station. Whether or not it will be advisable to locate the station there permanently will depend on the location of the railroad, which doubtless will be built into that region in the near future. If the railroad does not pass within a few miles of this tract, I would recommend that the location be changed to some place near the railroad.

The tract lies in the angle between the Copper and the Klutina rivers. On the low ground near the Copper River there is a stretch of good sized timber, which will furnish material for the necessary buildings. As one goes away from the Copper River the land rises in a succession of benches, and not by a gradual ascent. Each bench rises abruptly from the preceding to a height of from 50 to 100 feet. The ground is level on each bench, as though it had been terraced by some gigantic force.

Messrs. Rader and Neal spaded up a patch of ground on each of three of these benches and seeded part of the ground thus prepared to winter grains, wheat and rye, and they also seeded some grasses. I directed them to build a cabin and a barn, but they found that the

proper location for the buildings was some distance from suitable building timber, and having no means to transport the logs they put in their time in clearing and preparing ground instead. Mr. Neal will haul the logs this winter on the snow and put up the buildings in early spring, before active farm operations can begin.

Messrs. Rader and Neal arrived at Copper Center on July 17. The former remained there until August 23, when he left for Valdez on his return trip to Sitka. Mr. Neal, who will remain in charge of the station, stayed there until October 1. There was then a snow fall of several inches, which prevented further work in clearing land, and, having no building and little equipment, he could do no further work; so he too returned to Valdez.

By arrangement with Mr. F. C. Schrader, chief of a geological surveying party which operated in the Copper River country last summer, a team of horses for the use of the station was obtained from among the pack horses used by him, after his work was finished. These horses were sold on his return to Valdez, but he permitted Mr. Neal to select a team of good horses before the sale. This team is now at Valdez, and through the courtesy of the War Department we have obtained permission to stable them temporarily in the military barn at that place.

An equipment of agricultural implements has been purchased and shipped to Valdez. It consists of the following: Two plows, a smoothing harrow, a disk harrow, a mower, and a light wagon. Mr. Neal has also been supplied with hand tools and a set of carpenter's tools. In the latter part of January or early in February, when a trail has been broken, this equipment will be taken inside on sleds and Mr. Neal will then remain at the station permanently. Only implements absolutely necessary to work the ground will be sent in at present. It is hoped that the projected railroad may be built next season, so that a more complete equipment can be sent in with greater ease and less expense.

The first season's work will be expensive; labor will cost from $3 to $5 per day and board, and at least one man must be hired for the summer season. Transportation of the equipment will also be expensive. It is estimated that it will cost about $5,000 to put the station on a working basis. It is planned to clear and break about 50 acres of land, if possible, during the coming season. For the first few years experiments should be directed chiefly to the growth of grains, vegetables, and forage plants. When we shall have learned from these experiments which varieties can be depended upon to mature, the work should be extended to embrace animal husbandry. Grain growing and stock raising will be characteristic features of farming in the Copper River Valley.

Detailed reports by Messrs. Rader and Neal are submitted herewith.

REPORT OF MESSRS. RADER AND NEAL ON THE COPPER RIVER EXPERIMENT STATION.

Prof. C. C. Georgeson,

Special Agent in Charge of Alaska Investigation.

Sir: It having been decided to establish an agricultural experiment station in the Copper River Valley, we set out under your instructions from Sitka on July 2, with Copper Center as our destination. This place had been selected as seeming to be the most suitable and representative of possible agricultural development along the military trail from Valdez to Eagle. We arrived at Valdez July 6, where we purchased our outfit and hired three pack horses and an experienced packer. Leaving Valdez July 11 for the interior, we proceeded as far north as Copper Center, 103 miles from Valdez, where we arrived July 17. Mr. R. Blix, the postmaster, offered us the use of one of his cabins, which offer we accepted, and there arranged eating and sleeping quarters.

On the morning of July 18 we began the task of selecting suitable grounds for the proposed station. After exploring the country for several miles around we selected a tract of 775 acres, which seemed the most desirable tract that could be found, considering soil, elevation, and exposure, together with accessibility to the military road, and it is also about the only location we could find with living water, which can be brought into use for irrigation purposes, if desired, in case of drought. The stream also will furnish water for the stock and some considerable power can be developed, if desired.

After the east line was established we began the clearing of land for fall seeding. In the meantime we also cleared a small place at the most desirable building site, and, pitching our tent, we moved out on the reservation July 24.

Trail.—The trail from Valdez to the interior passes through a country of great beauty and grandeur. Traveling in an easterly direction up Lowe River for some 25 miles to the foot of Thomson Pass, the trail crosses the Chugach Range and pursues a general northeasterly course down Ptarmigan Creek and Tonsina River to the junction of the latter with the Kenata River; then leads up the Kenata and crosses Kimball Pass and down into the Tonsina Valley, about 70 miles from Valdez, where the traveler encounters the first land suitable for farming. However, there is an abundance of grazing land all along the trail, profusely set to redtop and bunch grass; also, many flowers and berries of various kinds are seen along the trail.

Approaching the Tonsina Valley, we came into a broad, flat country, about 8 miles from the river, covered with small timber. The soil seemed very shallow, though rich at the surface, and any cleared

places are covered with grasses of several species. The remainder of our journey to Copper Center was simply through a continuous flat country, and as we advanced the soil deepened and the vegetation became more luxuriant.

Location and area.—The tract selected comprises 775 acres of land. It lies in the angle between the Copper and Klutina rivers and about one-half mile to the northwest of Copper Center. The east line begins on the bank of the Copper River and extends south three-fourths of a mile and to within 1,000 feet of the Klutina. The south line extends $1\frac{1}{4}$ miles up along the Klutina, nearly touching the river bank in some places. The west line extends from about 1,000 feet off the bank of the Klutina for 1 mile north nearly to a high bluff about three-fourths of a mile back from the Copper. The north line extends east 4,620 feet, touching the Copper, then following down the river in a southeasterly direction 2,379 feet to the place of beginning. The tract is about 103 miles from tide water and 140 miles from the mouth of the Copper River and 110 miles from its source.

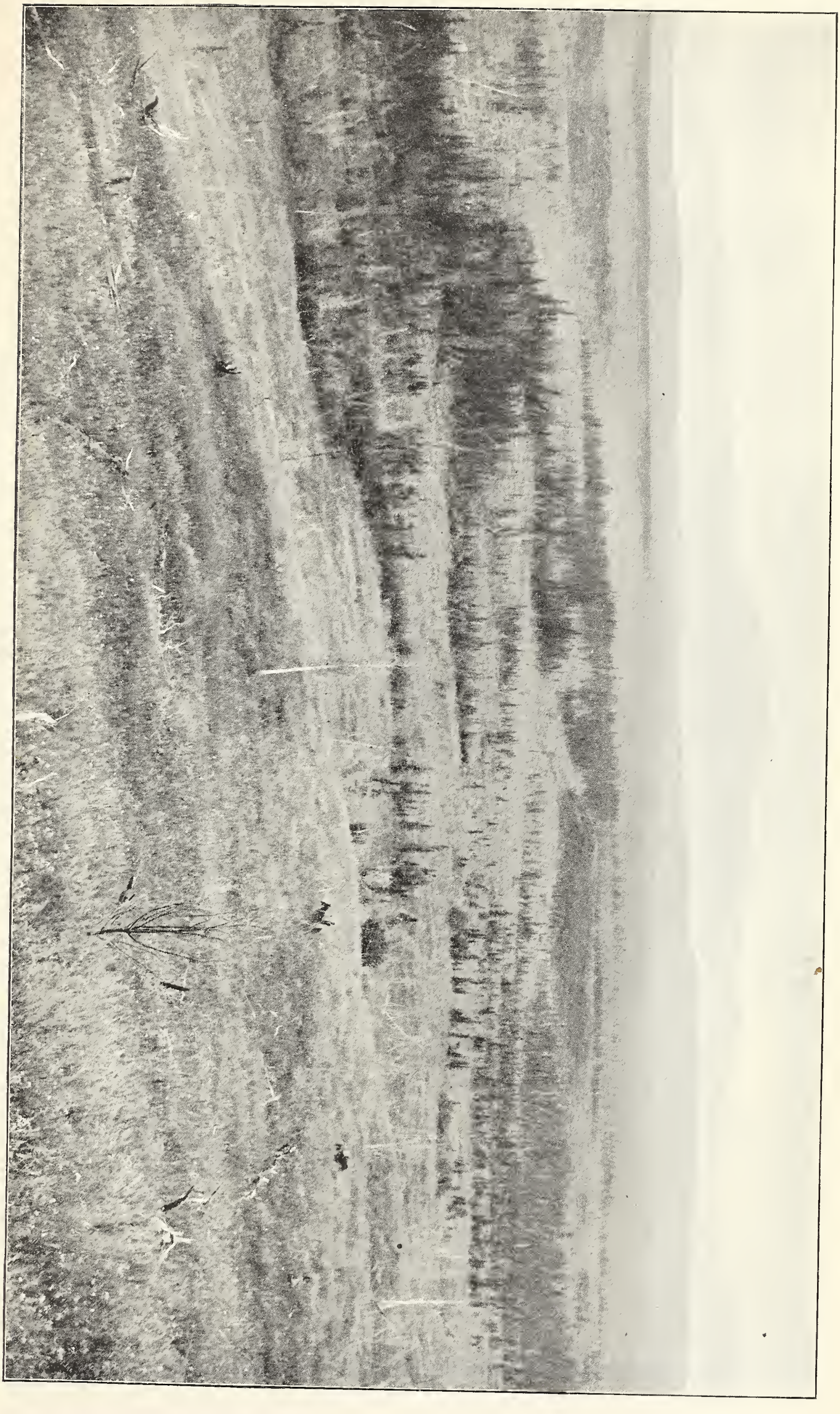
Topography.—The valley as a whole is a broad table-land of slight relief, sloping with the Copper River and extending from the Matanuska plateau, at about 3,000 feet elevation, for more than 100 miles down the river to Wood Canyon, where the valley floor is about 1,200 feet above sea level. The valley is estimated as comprising at least 35,000 square miles of agricultural land. The tract of land selected consists of a succession of benches or terraces, from a few feet above the river to probably 200 feet at the highest point, each bench rising abruptly to its regular height from the bench below it. The trend of these benches follows the course of the Copper River, and finally circling off toward and up the Klutina, the location being only about 1 mile from the confluence of the two rivers.

There is a small creek on the first level above the Copper, which forms a slough, but furnishes a minimum of from 30 to 40 miner's inches of water when not frozen.

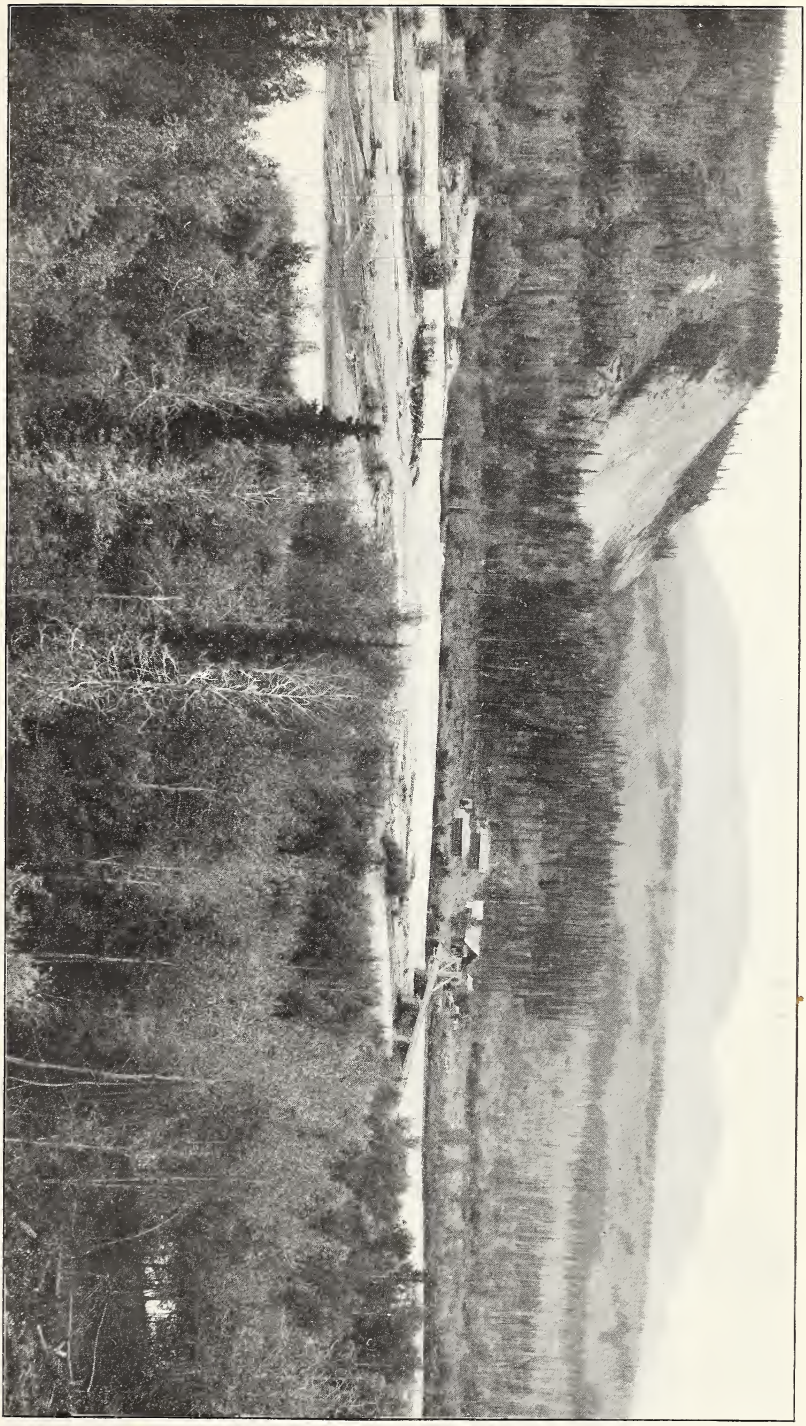
Altitude.—The altitude of the station at the lowest point is 1,050 feet, while the upper bench is fully 200 feet higher.

Soil.—It is conceded beyond question that the Pleistocene and Recent deposits, which have filled up the Copper Basin for several hundred feet in depth, were carried down from the Wrangell and Alaskan ranges with the great ice sheets of the Glacial period, which is, geologically speaking, very recent. This theory is sustained by the presence of gravel within the length and breadth of the valley, the tributary valleys being veneered by the same kind of surface deposits.

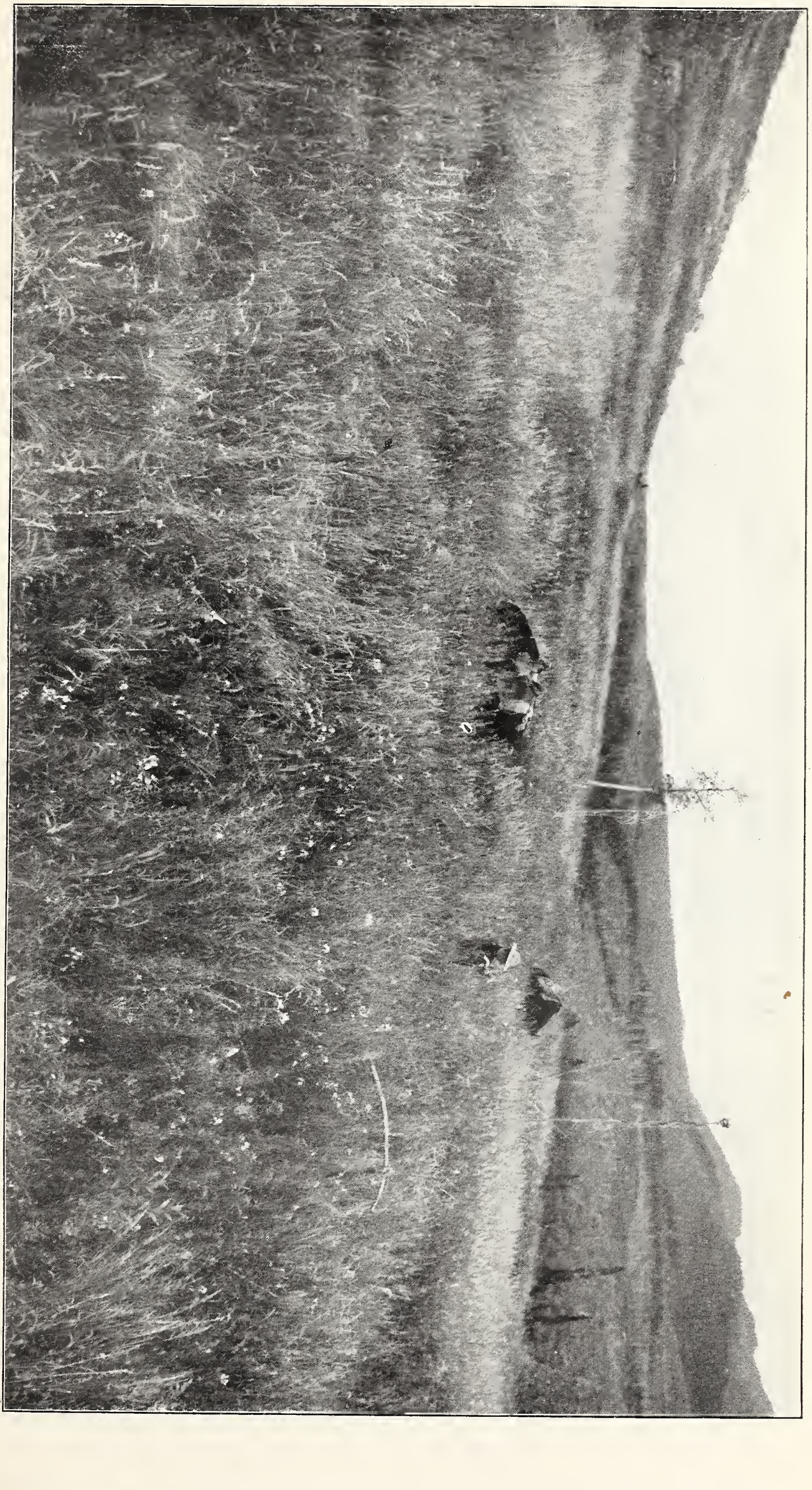
Immediately above this gravel deposit we find a stratum of sand covered with and sometimes intermingled with bowlder clay for 6 to 15 inches, and in some instances as much as 2 feet of this clay is found on the station. Above the clay there are several inches of silt, or rock



ALASKA STATIONS—COPPER RIVER VALLEY NEAR THE MOUTH OF TONSINA RIVER.



ALASKA STATIONS—TONSINA RIVER AND BRIDGE.



ALASKA STATIONS—COPPER RIVER VALLEY NEAR THE CHITINA.

flour, which becomes loaded with decomposing vegetation, and, where recent fires have not invaded, there are 3 to 4 inches of leaf mold, usually overgrown with moss. The soil as a whole is of a very friable nature, and where fires have run through and burned up the moss and leaf mold the soil pulverizes easily when broken. The clayey stratum, or subsoil, is less pulverous. The gravel is usually 2 to 3 feet below the surface, but where the land is more or less swampy it is deeper to the gravel and the soil is better.

Vegetation.—The prevailing vegetation throughout the Copper Valley and valleys tributary to the Copper is spruce forest. It is said that the trees frequently reach a diameter of 3 feet, but in the vicinity of Copper Center the timber is small and very close together. The largest trees seen do not exceed 15 inches in diameter. These are along the river, where the drainage is good. On the higher benches and in swampy places the average is probably 6 to 8 inches in diameter. Pioneers tell us that the timber on the other side of the Copper River, opposite the station, is somewhat larger, many trees being fully 20 inches in diameter.

The spruce timber grows rather tall and straight as candles. Usually the branches are dead for 6 to 8 feet above the ground. The wood is very knotty and hard to split. Fires have devastated much of the forest, and cottonwoods of two or three species frequently occur after the spruce is killed.

There are also some birch, alder, and willow, and occasionally the balsam poplar. But these occur mostly as shrubs or underbrush. In the vicinity of Mount Drum the birch is said to attain a considerable size—sometimes as much as 10 inches in diameter. The Indians make use of these trees for bows and arrows and numerous other articles.

There are two species of the willow, which occupy almost all marshy places. When found on higher soil among the timber, one species, the diamond willow, grows up brushlike, but rather straight for several feet in height. We also found the wild currant, both red and black, the low-bush cranberry, grouseberry, blueberry, swampberry, mossberry, and some others, the names of which are not known. The red raspberry is found along the trail for 60 miles out from Valdez.

Natural meadows.—While we found few natural meadows, and those of but small area, near Copper Center, prospectors report a number of meadows of considerable extent farther up the Copper River. We were informed of a meadow of about 100 acres near the mouth of the Tonsino River. There is also a small meadow of a few acres along the Klutina, 4 miles above Copper Center. The latter, and about 3 acres within and adjacent to the boundary lines of the reservation, are about the most available to the station.

Mineral resources.—Much has already been said through the press on this subject, but it may be added that each year brings forth new

and rich discoveries in gold, copper, lead, and tin. A number of new coal beds have recently been found. Platinum sand is found in considerable quantity near Mount Drum, but no real development work has been done as yet.

The strike in gold placers this season on the Nazina and other tributaries of the Chitina is thought to be a second Klondike, and from the latest developments, as the season closes, it certainly is an Eldorado, and no doubt will cause a great influx of people to that section of the interior. There is also a strike reported from the Mantasta Divide, and one at Yaktag, on White River. A big strike in oil is reported at Cotella, near Kayak, 30 or 40 miles from the mouth of the Copper.

Work accomplished.—The station has been surveyed with a pocket compass, the lines brushed out and blazed on the north, east, and south sides, and all the corner posts set and properly marked. Three small tracts on as many elevations, or benches, have been cleared, fenced, spaded up, and seeded to 9 varieties of grasses, 6 of winter wheat, and 4 of winter rye. Most of these seeds were sown on each of the three benches. There were about 2 tons of hay made from the meadow on and adjacent to the station and put under cover. One-half acre of land was cleared for a building site, and a whipsaw frame made for spring sawing while the snow is leaving.

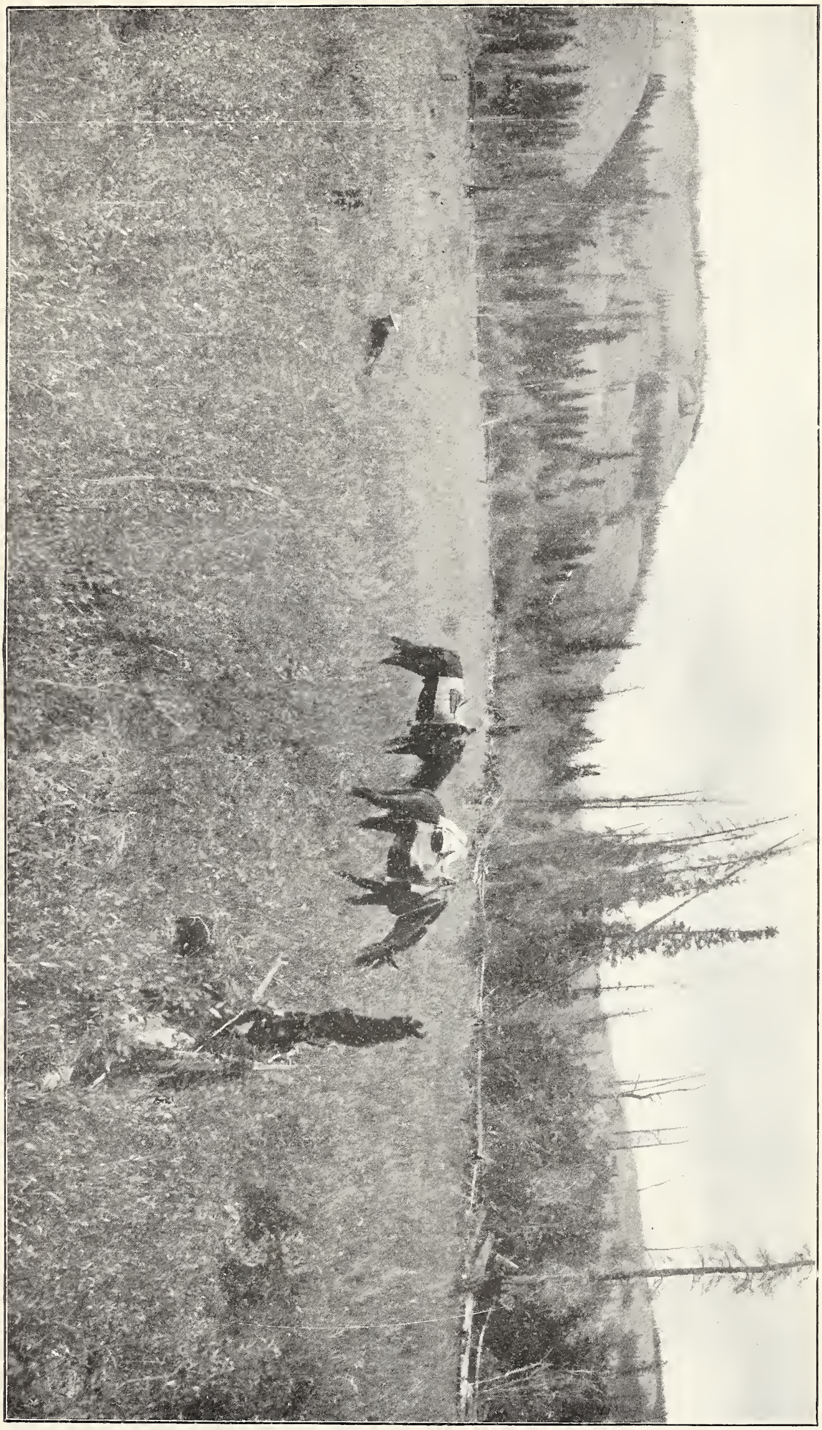
The general work of the season being that of clearing up land, we now have 8¾ acres ready for the plow, aside from the grain tracts already seeded and the half acre above mentioned, all of which will total 9½ acres. In conjunction with the clearing we have built 55 rods of fence (Pl. XV).

Gardens.—At Valdez a number of gardens were seen, containing all the hardy vegetables, apparently as good as we are accustomed to seeing in the States. It is not uncommon to see turnips weighing 6 and 7 pounds. Cauliflower and cabbage matured and did fairly well. Potatoes yielded well, but were a little watery.

There were some good gardens at Tonsino, 24 miles from the Copper River Station. Radishes, lettuce, spinach, peas, onions, potatoes, turnips, and ruta-bagas were doing well. (See Pl. XVI.)

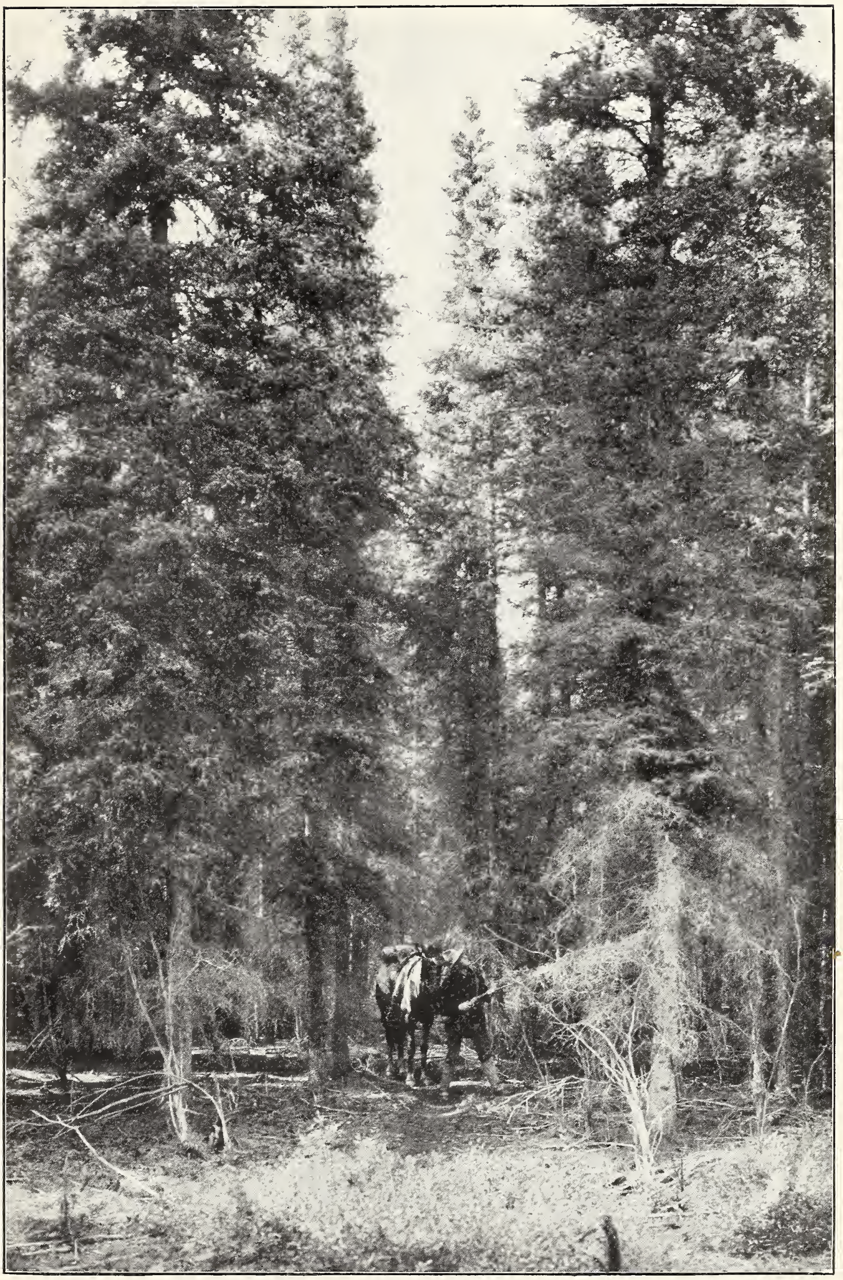
Several gardens were seen at Copper Center, and many hardy vegetables were growing there very satisfactorily. In Mr. Blix's garden the Windsor bean was growing and yielding well. The cabbage and cauliflower were planted too late and did not head. He planted his potatoes late and on low ground, which is subject to early frosts. Consequently they were killed by the frost on August 8. At that time the tubers were as large as hens' eggs. Mr. Blix put carrots and turnips away for the winter. These were of very good size, sweet, and highly flavored.

W. D. McGee grew turnips at Lake Abercrombie, 25 miles up the Klutina River from Copper Center, which speaks well for that section. They were large, smooth, and sweet, one weighing 3½ pounds

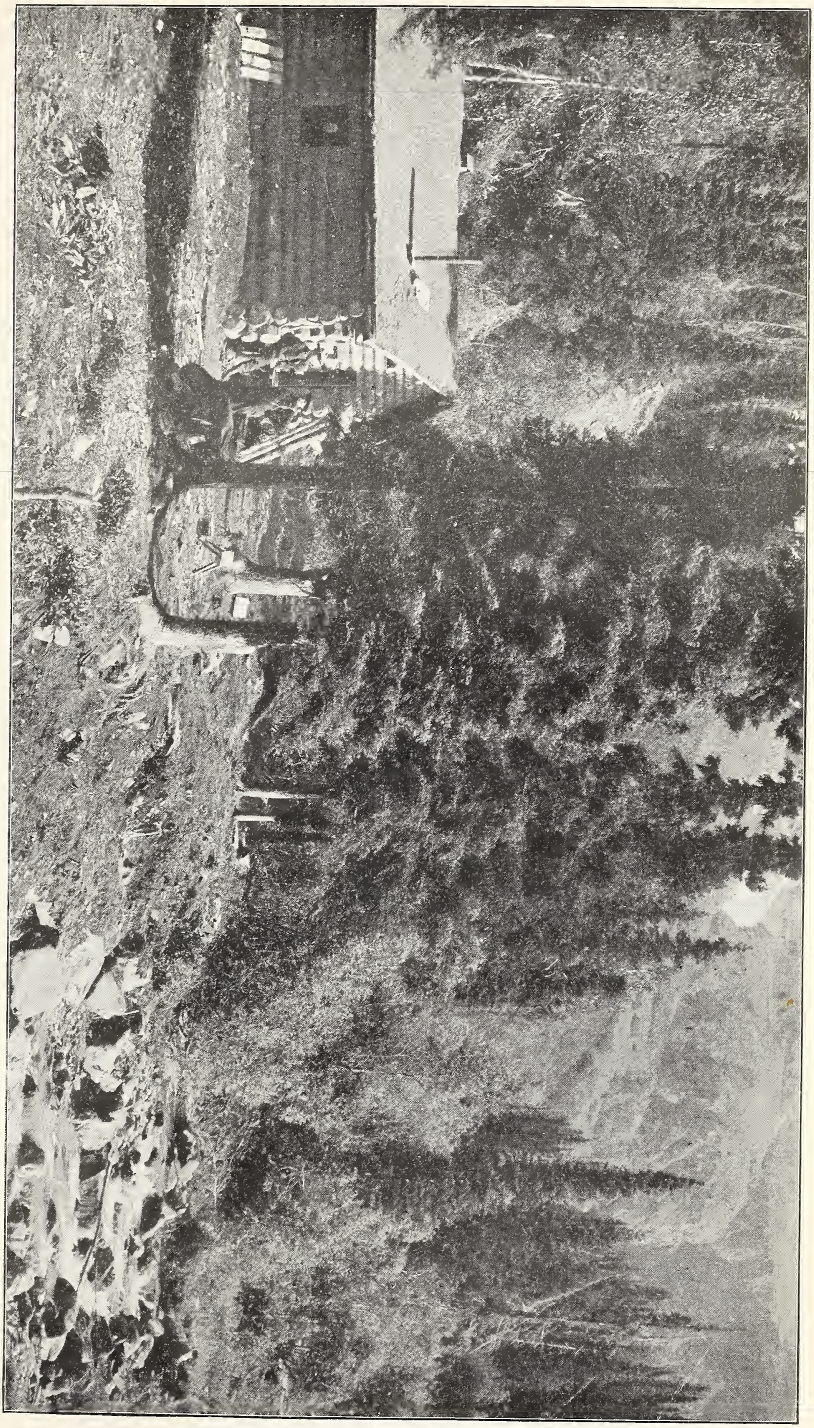


Alaska Stations—Cleared and Fenced Land on the Copper River.

ALASKA STATIONS—VEGETABLE GARDEN AT TONSINA BRIDGE.



ALASKA STATIONS—SPRUCE TIMBER ON THE TRAIL BETWEEN TONSINA BRIDGE AND COPPER RIVER.



ALASKA STATIONS—MILLARD'S CABIN, AND IN THE BACKGROUND, $1\frac{1}{2}$ MILES DISTANT, THE LOCATION OF THE FAMOUS NICOLAI COPPER MINES, 150 MILES FROM VALDÉZ.

and measuring 6¾ inches in diameter. He also planted lettuce, radishes, and peas, all of which matured and did very well with little or no care after planting. The land was new, but manured some.

Grains and grasses.—Along the military trail we found oats headed out when we arrived July 17; also a few stalks of wheat and barley just heading. The oats were in the milk by August 6, and all that escaped the loose stock matured good grain. The wheat and barley were eaten off before they filled. Heads of wheat were seen elsewhere along the trail which did mature, and the grain was plump and hard.

Several stalks of timothy 2 to 3 feet high were found, but the heads seemed unusually short. Also several stalks of red clover in full bloom August 1 and well covered with foliage. One or two stalks of white clover appeared.

Growing in Mr. Blix's garden at Copper Center were Finnish Black oats. This variety was seeded May 17. The growth was very uneven, averaging about 2 feet. It headed out very well and matured good grain August 22. Burt Extra Early oats, seeded May 17, made 2 feet of growth and matured August 27. The heads were well filled.

Manshury barley, seeded May 17, made a growth of 1½ to 2 feet. The grain matured by August 25 and is of very good quality.

Emmer, seeded May 17, being sown broadcast, germinated poorly. The growth was poor, owing, perhaps, to the unusually dry season. The average was about 2 feet, and the heads did not fill. The same variety seeded on the same plat in 1901, sown in drills 1 to 2 inches deep, made a growth of 5 feet and filled well. It is well to add that there was more rainfall that season.

Orchard grass, brome grass, fescue, and timothy were seeded May 17, all of which made a fair growth and formed a good sod. The timothy headed some and looked very encouraging. Hassock grass failed to germinate. Alsike clover, seeded May 17, came up sparingly and made 6 to 10 inches growth. Some blossoms appeared early in August.

SEEDING AT THE STATION.

The following grains and grasses were sown in drills about 1½ inches deep July 28, 1902; final notes taken September 29:

Grasses.—Timothy germinated well and made a growtn of about 1½ inches by the end of September. Redtop germinated very slowly and only made about 1 inch growth. Perennial rye grass germinated well and made a growth of 1½ to 2 inches. Tall oat grass germinated well; growth, 2 inches and over. Smooth brome grass germinated well and made a growth of 2 to 3 inches. Orchard grass germinated well and made a growth of about 2 inches. Hair grass germinated slowly and rather poor; growth, 1½ inches. Meadow foxtail germinated rather well; growth, 1 to 1½ inches. Meadow fcseue germinated well and made a growth of about 2 inches. The time required for most of the above to germinate was 12 to 16 days.

Wheat.—Yaraslof (No. 2791) germinated well; time, 7 days; growth, 3 to 4 inches and began stooling. Russia Winter (No. 2956) germinated poorly; time, 12 days; growth, 2 to 3 inches and began stooling. Russia Winter (No. 2958) germinated well; time, 4 to 5 days; growth, 3 to 4 inches and began stooling. Swedish Winter germinated well; time, 5 days; growth, 3 to 4 inches and began stooling. Swedish Winter (No. 102) germinated well; time, 6 days; growth, 4 to 6 inches. This variety did not show any signs of stooling, but began jointing about the middle of September, and by the end of the month every plant had thrown out a single stalk. The early frost has seriously injured, if not killed, the plant.

Rye.—West Virginia Winter (No. 5905) germinated well; time, 7 days; growth, 3 to 5 inches and began stooling. Russian winter (No. 2961) germinated only fairly; time, 8 days; growth, 3 to 4 inches and just began stooling. A few plants had begun jointing and were frozen. Swedish winter, germination only fair; time, 7 days; growth, 3 to 4 inches and stooling. Schlansted (No. 5031) germinated well; time, 7 days; growth, 3 to 4 inches and stooling. A few plants were jointing, but were injured September 29. The duplicate plats were all sown broadcast July 29, and were much slower germinating and did not make nearly as much growth.

General outlook.—The Copper Valley is one of vast area, and although somewhat difficult to get into at present it is believed the time is near at hand when thousands of homes will be established there. (See Pl. XIX, fig. 2.) With her broad acres of alluvial soil capable of producing vegetable crops of untold values, her heavy forests, and her great areas of rich grazing land only awaiting the advent of the dairy herd, and with many possibilities still undeveloped, no one can say what changes may take place in the near future. Enough has already been seen to convince us that wheat, barley, and oats can be successfully and profitably grown, and that meadows can be made here the same as in the eastern Middle States. Redtop is native and grows 5 to 7 feet high, seemingly, wherever the seed may fall. Timothy, as seen along the trail, or wherever horses have been fed, would indicate that it should become one of the meadow grasses, and we believe red clover can be successfully grown.

We would recommend stock raising and dairying as the most profitable industries. The average farm should comprise at least 320 acres. This would admit of a small reserve whereon fuel and timber for home use might be perpetuated. There is also need of good-sized farms, as stock will have to be sheltered and fed seven months in the year.

Very respectfully,

F. E. RADER.
J. W. NEAL.

FIG. 1.—ALASKA STATIONS—CLEARING IN PROGRESS, COPPER RIVER STATION.

FIG. 2.—ALASKA STATIONS—VIEW OF COPPER RIVER VALLEY NEAR COPPER CENTER.

RIPE GRAIN.

Samples of ripe grain have been received from several other parties, besides the samples from Rampart, above referred to. M. W. Lane, of Haines, Alaska, writes as follows, under date of September 4, 1902: "Please find inclosed samples of grain grown on my place 1 mile west of Haines, Alaska. These samples, which are Siberian wheat, Norway oats, and Norway barley, were cut just ten weeks after planting." The samples referred to were ripe and of fair quality.

S. Blackburn, of Juneau, Alaska, sent me, in the latter part of September, ripe samples of Romanow spring wheat, and of Burt Extra Early oats. Small patches of these grains have been grown by him the past season.

H. S. Tibbey, of Coal Harbor, Unga Island, sent me small samples of Romanow spring wheat and Manshury barley. The samples were cut September 11, at which date the wheat was not quite ripe. The barley was fully ripe, however. The samples were accompanied by the following notes: "Romanow spring wheat planted on undrained ground May 11. Manshury barley planted May 11. June 12, 1½ feet high. Cut September 11, four months after planting. The weather from August to September has been very unfavorable. The wheat planted at the same time is looking finer than the barley, but it is not so far advanced toward maturity."

I also received a fine sample of Finnish Black oats from Rev. S. H. Rock, of Nushagak, on the Nushagak River. The grain was ripe and of good medium quality.

M. W. Gorman, a botanist in the employ of the United States Department of Agriculture, who has been collecting in the region about Lake Clark, north of Cook Inlet, informed me that on September 4 of the present year he found a small patch of perfectly ripe oats at Iliamna village, on Iliamna Lake.

J. W. Neal, in charge of the Copper River Station, mentions in his report that he saw ripe wheat, barley, and oats in the interior along the trail and at Copper Center.

In several of the reports from the seed distribution mention is also made of grain which matured.

All of the foregoing afford still further proof that Alaska has agricultural possibilities worthy of consideration.

INDIAN GARDENS.

That the Government seed distribution is a great help to the Indians as well as to the white settlers in Alaska is proved by the fact that the Indians in several places have undertaken to raise gardens as a result of this distribution. Missionaries in all parts of Alaska

encourage them in this work and aid in the distribution of the seed, and the same is true of the white miners and prospectors in many places, who have made their homes temporarily among the natives. The following brief extracts from letters received bear upon this point. Mr. Fillmore, of Seldovia, writes: "I have given some of the seeds to the natives to plant, and I will show them how to plant them. Some of them had very good gardens last year and this year they will have more and better gardens, as they have received more and better seeds."

W. L. Bunard, of Kasaan, Alaska, writes: "I would like you to send me some more seed. We have here 42 Indians who raise gardens for themselves and I would like to help them out with seeds, but the few you have sent me will hardly go around to all of them."

C. B. Olssen, of Cape Elizabeth Island, writes: "I will distribute the seeds which you sent me among the natives. Nearly all of the natives in English Bay have small gardens in which they raise potatoes, turnips, etc."

Rev. James W. Kirk, of the Presbyterian mission at Eagle, Alaska, writes: "I wish to do what I can for the Indians, as their case is becoming more and more hopeless each year, save as they turn to modern pursuits. I do not find them all disinclined to gardening, as some of them are willing to labor, and do it very well. I will try to do what I can for them, and hope you will send me the seeds and that there will be a good proportion of turnips, carrots, parsnips, and lettuce." In another letter he says, "They (the Indians) are successful in raising turnips, and I hope you will send seed of this kind, for then they are sure of something."

Reference to Indian gardens is also made in many of the reports from the seed distribution.

At Sitka several Indian families raise creditable gardens, and in this connection it is pertinent to add that Miss Cassia Patton, until recently teacher of the Sitka school, annually offers cash prizes for the best three gardens made by Sitka Indians, the prizes being awarded to the first, second, and third best efforts. The offer of these prizes not only stimulates them to raise gardens, but they consider it an honor to win a prize.

LETTER FROM AN ESKIMO.

The following letter from an Eskimo, a native of Unalaklik, is of special interest, not only because his report shows him to have been a successful gardener, but more particularly because he is proof that the natives of Alaska are susceptible of civilization, and that they can be interested in gardening if they are furnished with seeds and instructed in their culture:

UNALAKLIK, ALASKA, *October 1, 1902.*

DEAR SIR: Your seeds received and tried. They were planted the 1st of June last and the crops harvested on September 25. My garden did well. The turnips grew

to weigh from 4 to 5 pounds, on an average, and some of them weighed up to 7 pounds. The cabbage and cauliflower were fine. Lettuce, parsnips, peas, radishes, cress, ruta-bagas, and carrots were planted and did well. All of these are a very great help to us. We use them in our kitchen.

I am expecting to have my people interested in raising gardens. Quite a number of them have asked me for seed, and I will ask you to kindly send some seed to us. George Kutok, a young man at Unalaklik, also wants some. He is very much interested in garden work.

We also planted flowers on the 1st of June, pansies, morning glories, wall flowers, poppies, marigolds, mignonette, nasturtium, and these are still in bloom in our windows.

I am thankful for the seeds you have sent us. My wife is greatly interested in flowers. We are natives of Alaska, born at Unalaklik. We have learned to read and write from the Swedish missionaries at Unalaklik, for which we are very thankful to them.

Yours, truly, STEPHAN IVANOFF.

ALASKA-GROWN POTATOES KEEP WELL.

It is occasionally stated in the papers that Alaska-grown potatoes can not be kept over winter; that they are watery, small, or otherwise worthless. In proof that such statements are not always reliable I quote Rev. James W. Kirk, of Eagle, above referred to. Mr. Kirk writes: "I never saw finer potatoes than those raised here. All winter we have used potatoes raised at Eagle, and have found them excellent." In another letter he says, "Our cellar has worked splendidly, and we have been using potatoes all winter which were raised in the Yukon Valley. They are fine and keep well."

AGRICULTURAL INSTRUCTION FOR THE INDIANS.

This brings me to mention a subject which in my view is of vast importance to the natives of Alaska, and that is that an agricultural teacher should be employed during the summer season to teach gardening to the natives. In many places their condition is becoming desperate. With the influx of white settlers their chances for making a living at their usual pursuits, viz, hunting and fishing, are constantly diminishing. The fur-bearing animals are practically exterminated, and the sale of furs to trading companies, which formerly enabled them to procure a large share of their provisions, is well nigh a thing of the past. Even the game animals, on which they have largely subsisted, are becoming scarce in many sections. In some sections their fishing grounds are also encroached upon by the canneries, and unless they are provided with means of subsistence other than those referred to many of them must of necessity soon be brought face to face with starvation. As a remedy, I recommend that they be instructed in agriculture and particularly in the growing of the more common vegetables. They are, as a general thing, totally ignorant of this subject.

The foregoing extracts show that although they may not be apt scholars they are willing to learn and to take advantage of such resources as a garden may give them, if they only are supplied with seed and shown how to go to work. While this work can scarcely be said to be the proper line of work for an experiment station, it could probably be conducted under the supervision of the experiment station to better advantage and along more practical lines than would be possible under other departments of the Government. An active young man, who has the interest of the work at heart, who is familiar with the conditions, and who has the required scientific knowledge and practical skill, should be employed to travel from village to village all through the season, distributing seeds, particularly seed potatoes, and give them practical lessons in the planting and cultivation of common garden crops. This work could undoubtedly be done in a large degree in conjunction with the native schools. The teacher of each school would be intimately acquainted with the condition and needs of the people, and he or she could act as an agent in the distribution of seed and as an assistant in giving the required instruction.

Five thousand dollars appropriated for this purpose would do more good now in preventing starvation than will $100,000 later on as a relief fund when the point is reached that they must be fed by the Government or die of starvation.

DISTRIBUTION OF SEEDS.

During the past year seed has been distributed to about 750 settlers located in all parts of the Territory. It consisted of the leading hardy kinds of vegetables, a few early maturing grains, a little clover and grass seed, and also a little flower seed. The policy of distribution of seed by the Government has proved itself to be eminently proper and decidedly popular with the people. It is so difficult to obtain seed in the interior that unless they are supplied from this source comparatively few would raise gardens. The distribution, therefore, not only is an aid to the settlers, but it stimulates the development of agriculture. It is also cooperative experimentation on an extensive scale. Vegetables and grains are grown at many points in out-of-the-way places where it would be impossible for the station to conduct direct experiments. The information proves of much value to the work in hand.

I recommend that this seed distribution be continued and extended. The miners and prospectors on the rivers and creeks in the interior, far from the seacoast, appear to be especially pleased with the seed sent them. The gardens which they are thereby enabled to raise will help to reduce the cost of living, and, what is perhaps of more importance in

regions where they are compelled to subsist largely on canned goods, they are an aid to good health.

REPORTS FROM SEED DISTRIBUTION.

The letters and reports herewith submitted from settlers in nearly all parts of the Territory deserve to be read for the information they contain. A careful perusal of these letters will give the reader a better insight into conditions in Alaska than it would be possible to impart in a detailed article on the subject, although they are not designed to be anything more than simple reports of the results obtained from the seeds sent the writers.

INDIAN GARDENING IN SOUTHEASTERN ALASKA.

November 19, 1902.

Dear Sir: The natives—Tongas, Cape Fox, Tsimpshean, and Hydah—in this section take more kindly to gardening than heretofore. The Tsimpsheans, at Metlakahtla, do more than any of the others. Their only hindrance is in their lack of gardening area. They do not till the ground anywhere else than around their town houses, and these lots are only 80 by 90 feet square. If in some way they could be induced to clear grounds elsewhere than their town lots, they could soon supply some of the Alaska market. But as it is they raise only what they consume.

The Tongas and Cape Fox Indians do some gardening in their fishing places, and not at their homes. Within the last five years many new families which have always lived by hunting and fishing have taken some interest in raising some of their articles of food. Like the people of Metlakahtla, they have cleared only a very limited area of ground, and this usually at some old deserted town.

The Hydahs, at Kasaan, do some gardening to a very limited degree. They have good lands, which are capable of a large crop.

The crops raised here are potatoes, turnips, carrots, parsnips, cabbages, onions, and radishes. There are a few others, but these are the principal ones, especially the first three. They grow very nicely to full maturity and have a good flavor. Some of the families raise all that they consume the year round, and they depend but little on the grocery stores.

The other things raised are raspberries, strawberries, gooseberries, and blackberries. These grow abundantly. With experiments we have carried on, cherries and apples can be raised here. Wheat can grow, but we have not yet tried to raise it to do it justice. The natives are anxious to know how to raise fruits and some of the cereals.

Many of the families among the natives keep chickens. Three of them raise White Pekin ducks and the common turkeys. One family is now trying to raise cattle. This is the extent of live stock among them. There are large pasturages here for cattle, and there is nothing in the way of raising cattle except that the natives have not yet interested themselves in this work.

I suggest that a personal visit to these people by you or your authorized agent in the interest of agriculture be made some time next spring or early in the year. You can then talk with them intelligently and they can ask questions of you on the subject. I suggest also that the Government send to this section some cherry and apple trees for distribution among the most progressive in gardening. If the Indians are properly taught the cultivation of the soil, they will then contribute to the building up of this large and wild territory to be country it ought to be.

Yours, very truly,

Edward Marsden.

INDIANS RAISE A "WORLD OF CABBAGE."

KASAAN, ALASKA, *October 25, 1902.*

DEAR SIR: I have made inquiries here of the Indians as to how the seed came up this summer which you sent me in the spring. Am glad to say that with a few exceptions they have turned out all that could be wished. One thing they have done for the first time is that they have raised a "world of cabbage." I took some of the cabbage seed that you sent me and made a large hotbed and when the plants came up I gave the Indians all they wanted and showed them how to set the plants out and how to take care of them. As for my own garden, it did well under the circumstances, as I was called away from home early in July and left my family to take care of it, and as they were not thoroughly posted on gardening some things did not do as well as they would had I been here. However, I shall have in the neighborhood of 30 bushels of potatoes and about the same amount of turnips. Ruta-bagas and carrots did finely, and I will probably have all I want and some to spare. Have 200 head of cabbage, and some are large and solid. My beets and parsnips did not do as well, all for the lack of care.

Yours, truly, W. T. BERNARD.

VEGETABLES IN PLENTY.

PRINCE OF WALES ISLAND,
Grindall, Alaska, October 11, 1902.

DEAR SIR: Our wheat, oats, and barley were planted on raw land without drainage and fertilizer and did not attain a height of much more than 2 feet. They headed out and filled to some extent, and some of the barley ripened, but the oats are still green and in full head. All were planted June 1.

Our clover and grasses did nicely, especially the English rye grass which grew rank over 2 feet high and headed out. The clover and timothy made a fine growth and blossomed out six weeks ago and are still blooming and growing.

Our flower seed did not do much, as only a few grew and bloomed. Rhubarb made a fine growth and is still growing, as we will not have frost before November 15. On land fertilized with seaweeds we grew turnips, beets, parsnips, ruta-bagas, peas, spinach, potatoes, cabbage, rhubarb, and onions, all from seed except potatoes. They did as well as any vegetables I ever saw grow anywhere, and we have had vegetables to use all summer and still have plenty left for winter use. We also grew lettuce and radishes, which were all that could be desired, and much better than expected.

Yours, truly, ISAAC J. TOMLINSON, *P. M.*

A NOTE FROM LORING.

LORING, ALASKA, *October 9, 1902.*

DEAR SIR: In reporting growth of seed this year, would say that the wet weather in August prevented beans from maturing, but the ruta-bagas, turnips, parsnips, carrots, peas, lettuce, radishes, and onions were very abundant and rhubarb made a good growth and was ready for table use from May 1 until the past fortnight.

Respectfully, yours,

FREDERICK KNIGHT.

A KETCHIKAN GARDEN.

KETCHIKAN, ALASKA, *October 15, 1902.*

DEAR SIR: I received your seeds and planted same. The soil is situated on a hillside, is fairly dry, and consists largely of rotten vegetation and broken slate. I dug

the ground up about 6 inches deep and put on a thin coat of cow manure. Planted the seed on May 1, with the following results: Peas, cauliflower, parsnips, radishes, turnips, and potatoes all good. Beets small. Carrots fair size, very tender and sweet. Cabbage, big leaves and small heads. Lettuce good, very tender. Onions good, if the ground is not worked over 2 or 3 inches deep. Ruta-bagas good, 3 to 5 pounds each. I do not know of anyone raising grass or grain. The Indians here do not want to plant anything except potatoes.

Respectfully, AUGUST GROOT.

MOST GRATIFYING SUCCESS.

KETCHIKAN, ALASKA, *October 30, 1902.*

DEAR SIR: I did not plant any of your seed myself last spring, but I lived nearly all summer on vegetables from the garden of a near neighbor whom I supplied with seed. As far as I can learn nearly everybody who planted the seeds met with the most gratifying success. I am certain that the result has been a complete demonstration of the fact that we can grow in this section as fine vegetables of the hardy varieties as can be grown anywhere, potatoes, turnips, ruta-bagas, cabbage, carrots, parsnips, cauliflower, beets, radishes, lettuce, etc., while we can beat the world on berries.

Yours, truly, A. P. SWINEFORD.

GOOD GARDENS AND SUCCESSFUL GRAIN GROWING AT DOLOMI.

Under date of October 25, 1902, Mr. H. Heerdt, of Dolomi, writes me a detailed report of his experiments during the past season, which may be summarized as follows: He cleared a piece of ground which was not especially well adapted to gardening. The soil contained much rotten wood, but he manured it with ashes, spoiled fish, and other refuse. On this ground was seeded Romanow spring wheat, Burt Extra Early oats, and Manshury barley. These grains were all seeded April 20 and grew nicely and matured as follows: The wheat was ripe October 1, the oats September 1, and the barley August 15. The barley especially produced an excellent crop and superior grain. He seeded red, white, and alsike clover, and while they all grew the soil was too sour and the results were not striking. However, some volunteer clover which sprang up in better soil near the house made a very excellent growth. Orchard grass and timothy also seeded April 20, likewise made good growth, but volunteer timothy second year's growth grew to a height of over 4 feet with heads over 4 inches long.

He made one-half dozen seedings of lettuce at various times from March 25 to July 2, all of which produced lettuce of superior quality. That seeded on March 25 was ready for use June 1 and the seeding made May 24 was ready for use July 1.

Cabbage was seeded in boxes indoors March 25. The variety was Early Jersey Wakefield. Planted in the latter part of May, it grew fairly well and was ready for use by August 10. The heads were not large, but firm. His chief trouble with cabbage was that many of the heads burst open.

Cauliflower, Extra Early Erfurt, seeded in boxes latter part of March and treated like cabbage, produced very excellent heads by August.

Cucumbers and beans did not do well. Some small cucumbers were produced, but on the whole they could not be called a success. Beans were likewise a partial failure. Turnips and ruta-bagas were a marked success. Onions were seeded at four different dates from March 25 to May 25. The bulbs resulting from all seedings were nearly all of the same size. They were large enough to use for sets, but not large enough for the market. They averaged about the size of marbles.

Parsnips and carrots were seeded April 10 and produced fairly good roots, but none of them extra large. Beets were seeded April 5 and 15 and May 5. The leaves

were used for greens. If not for this the roots would have been larger, but they averaged 3 inches in diameter. Radishes were seeded on several dates, and all seedings produced excellent, crisp roots.

White mustard was a great success, but spinach, on the other hand, did not do well, as it ran to seed too early. A lot of nice rhubarb plants were produced from a setting made in the latter part of April.

DUG $1\frac{1}{2}$ TONS OF FINE POTATOES.

SULZER, ALASKA, *October 19, 1902.*

DEAR SIR: On May 15 I planted 35 rows of potatoes, each 55 feet long, one-half on new ground and the other half on ground on which I raised a crop of potatoes last year. In the above patch I dug $1\frac{1}{2}$ tons of fine potatoes, some of the largest ones weighing $1\frac{1}{2}$ pounds each. The ruta-bagas, turnips, parsnips, beets, peas, lettuce, radishes, and onions all did very well. I raised the onions from seed and they were as large as big walnuts. The rhubarb did not do very well, but may come out all right in the spring.

I had a fine lot of clover, both red and white, which grew to the height of 30 inches, and it is still in bloom.

Yours, very respectfully, A. SHELLHOUSE.

ABUNDANT PROFUSION OF BLOSSOMS.

JUNEAU, DISTRICT OF ALASKA, *October 29, 1902.*

DEAR SIR: From flower seeds, which I planted in boxes around my cabin, I was delightfully rewarded with an abundant profusion of blossoms of sweet peas, pansies, daisies, verbenas, and phlox in variety, notwithstanding the unusually rainy season.

Very truly, yours,

WM. N. C. WADDLETON.

GARDENING ON THE PORCUPINE.

PORCUPINE CITY, ALASKA, *February 19, 1902.*

DEAR SIR: I came here from Massachusetts in the fall of 1898, and have lived here ever since. I raised my own vegetables, potatoes, turnips, cabbage, beets, carrots, and onions from sets, but have had no success with onions from seed. Potatoes (Early Rose) grow fine, very nearly as well as in Massachusetts, and the cabbage is better, larger, more plump, and of fine flavor, the varieties being the Early Summer and Early Jersey Wakefield. On the river bottoms cabbage, turnips, parsnips, and carrots do finely, while potatoes do well only 100 to 200 feet above on sides of hills or uplands. Frost cut them in June, July, and August on river bottoms, while 100 feet above the frost does not bother them until after they are nearly ready to dig. Last year there was so much rain that the potato tops were green October 10 up on my sidehill patch. About the middle of October I dug them, and the frost had just cut the tops. A neighbor of mine had potatoes in the river bottom and they were cut down in July and August.

Yours, truly, HERMAN F. EMMONS.

REPORT FROM HAINES.

HAINES, ALASKA, *October 28, 1902.*

DEAR SIR: Allow me to say that my crop was very gratifying, indeed, and had I received the seed a trifle earlier am sure that vegetables and flowers would have sur-

passed my expectations. Of the flowers, the poppies, mignonette, sweet peas, and giant pansy did exceptionally well, while asters, giant marguerite, carnation, and Drummond phlox left something to be desired.

All the vegetables seem to thrive here, as also do the red and white clovers. I also raised strawberries here 5½ inches in circumference, sound and wholesome.

Yours, very respectfully,

JOHN RIPINSKY.

A LETTER FROM HOONAH.

HOONAH, ALASKA, *October 8, 1902.*

DEAR SIR: I prepared my grounds the second week in May. Used seaweed pretty freely and sowed the seed for my winter vegetables. I went below May 15, and as there was no one to hoe or give it any attention, I was surprised on my return to see as fine ruta-bagas and turnips as ever I ate. My beets and carrots were not as good as usual, for they required more attention. My flowers were not as successful as last year for the same reason. My white and red clovers were a success. I hear some of our native people have raised fine vegetables this season.

Yours, respectfully, M. J. MCFARLAND.

A SKAGWAY MARKET GARDEN.

SKAGWAY, ALASKA, *October 12, 1902.*

DEAR SIR: I have a garden of over 5 acres planted to small truck. It has a sandy soil, heavily enriched with stable manure; also use considerable nitrate of soda on growing crops with good effect. I have about one-half acre of cultivated raspberries, which are very prolific and of the largest size and the finest flavor I have ever seen and tasted. Sixteen thousand celery, the largest celery 3 feet high and 5 inches in diameter, and of better quality than the Colorado celery, which is the finest celery I have seen before coming here. Lettuce, radishes, green onions, beets, turnips, carrots, parsnips, rhubarb, cabbage, cauliflower, and peas are of the best qualities I have ever tasted, and produce larger quantities to the acre than in the States. I had about 2,000 Snowball cauliflowers planted this year. Many of the heads weighed 5 pounds. All varieties of turnips grown here are sweet, while my experience in Colorado was that most varieties grown were bitter, with possibly the exception of the White Egg. Potatoes are very prolific, but inclined to be watery; white potatoes have my preference, as they give the best satisfaction. Burbank has been most successful. I have grown cucumbers in the greenhouse for four years with good success. Wax beans have also done well in the greenhouse.

While all hardy and half-hardy annual flowers are the finest grown anywhere, pansies, especially, are far superior in size and quality to those grown in the States.

Salsify has not been a success, running too much to roots. Kale, parsley, spinach, mustard, and leek have all done well.

Very truly, yours, H. N. HOLMES.

SUPPLIED THE HOSPITAL WITH VEGETABLES.

SKAGWAY, ALASKA, *April 5, 1902.*

DEAR SIR: I broke the ground at the rear of the hospital for the first time. It was very sandy and full of stumps, roots, etc., but raised sufficient vegetables to supply the hospital pretty nearly all summer. I dug in all the manure and loam that I could get hold of. I had radishes, lettuce, mustard, parsnips, carrots, peas, turnips, cabbage, and cauliflower. Cucumbers I had no success with, although I can grow

them to perfection. My cauliflowers were a sight, 15 inches in diameter, some of them, and I notice that very few of them were grown by gardeners around here. They went for cabbage mostly, and they do not make the heart they should. I raised my plants in boxes in the house and transplanted most of them again in boxes, as the weather gets mild enough to put them outside, covering them in the evening, until the ground is ready, then they grow like "wild fire." All the vegetables I speak of were from Government seed, which I obtained by chance.

Yours, respectfully,

WM. H. TAYLOR, *Secretary.*

GARDENING AT SKAGWAY.

SKAGWAY, ALASKA, *March 12, 1902.*

DEAR SIR: I have a garden 50 by 100 feet, and last year I raised strawberries, cabbage, cauliflower, kale, carrots, celery, parsley, peas, beans, lettuce, spinach, and various other kinds of garden truck. Rhubarb was especially fine; potatoes were mellow and of fine size. Roses bloomed three times last spring. I planted cherry trees last spring, which bloomed three times likewise, but as the trees were too young I broke the blossoms off. This year I expect both apples and cherries to ripen.

Respectfully, yours,

HERMAN GRIMM.

EXTENSIVE MARKET GARDENS.

SKAGWAY, ALASKA, *November 15, 1902.*

DEAR SIR: At Dyea we raised about 31 tons of potatoes. They are good quality. Our early planting did the best. We planted as soon as the frost was out of the ground sufficiently to work it. We tried irrigating, but made up our minds that it is a detriment. We did not give it a fair trial, however, as the dam gave way at high water and flooded the potatoes for four days. We concluded that it is better to plant the potatoes early, while the ground is moist. The variety called the Milwaukee did the best this year. The Ohio is good, and we have no fault to find with the Burbanks. We tried 4 quarts of a new kind known as the Early Michigan. We found it so satisfactory that in time I think we will get the seed and plant it for our main crop.

We have from 20 to 25 tons of hay, mostly oat. The greater part of it is good. It rained so much in August that we made poor headway haying, but it was good weather through September. We cured a good deal of our hay under cover. We have some timothy, but I like the oat hay better and it is easier to cure.

We tried several kinds of vegetables at Dyea. Our carrots did fairly well, but I have seen much larger yields here in small patches. Our parsnips were a medium crop. We raised 1 ton. We had a big crop of turnips, both yellow and white, and our ruta-bagas were also a good crop. We raised about 1,000 bushels of turnips and ruta-bagas.

Part of our strawberries lived through last winter. We set out some new plants last spring, all of which made an excellent growth this season. The ones that wintered here are the thriftier plants, however, and they bore some fruit this season. We have hardly made up our minds yet whether we can raise them successfully. We have covered them less heavily than we did last winter and shall give them another trial.

I will now tell you something of the crops on the Skagway ranch. Our rhubarb did very well. We began selling May 30 and sold the last October 11. In all we sold about a ton. We raised two crops of cauliflower from the same ground; both

were fair crops. The second crop was the more even; not so many small ones and none very large. We sold the first on July 2 and the last October 1. We had a splendid crop of beets. I never saw better. We raised something over 4½ tons from 1 pound of seed. We set out 100 pounds of onion sets. We did not find sale for them all as bunch onions. We had 16 sacks of dry onions of good quality. We started some seed in the greenhouse and transplanted the young onions to the field. They grew to large size, but did not ripen off right. We raised a good crop of cabbage on the ground where we had our onion sets; also a crop of radishes and lettuce on the same ground as that on which our early turnips were raised.

We built a large storage building this season for carrying our vegetables through the winter. It is 30 by 60 feet, with 10-foot studding. It is double boarded, with tar paper between. We dug down 3 feet and banked it up 4 feet. We have a stove in it, but do not expect to have a fire except in the coldest weather.

Our Golden Self-blanching celery was a failure; most of it went to seed. What little did not was poor quality and poor flavor. Very little of the White Plume went to seed, and it is as nice celery as I ever saw. None of the Evans Triumph went to seed. It is harder to blanch than the White Plume, but I think is going to be a better keeper for winter use. We have the celery in our storage building, where it is blanching finely. We tried a few of the Flat Parisian cabbages again, but they do not give satisfaction for shipping trade. For an early cabbage I like the Alpha best, although I shall plant a few of the Jersey Wakefield again. We raised a good many of a kind called Long Keepers this year. For solidity and quality I never saw any cabbage equal to them, and they yield well. We shall depend on them for the main crop next year. We have about 23 tons of cabbage on hand now. We tried a little spinach, but it did not do well. It went to seed while very small. We had a hard time trying to raise early radishes and turnips out of doors on account of the worms. Can you tell me anything that will destroy them? Our peas were a great success. We picked the first July 4 and sold the last October 11. We had a large crop of wild raspberries on the ranch.

There were numerous small gardens in Skagway this season. Most of them were planted with Government seeds. They did very well. We tried raising tomatoes under glass this season. We filled in the ground floor of our hothouse with rich soil and set out some fine plants about the middle of June. The plants made a great growth and we got a good many green tomatoes, but only a very few ripe ones. There was not enough sun in the latter part of the season to make tomato raising profitable.

Yours, truly, H. D. Clark.

OPINIONS OF A PIONEER.

Skagway, Alaska, *March 15, 1902.*

Dear Sir: This is my third season at Skagway. Two years ago I was quite successful with all kinds of garden vegetables and potatoes, on new ground, with only a little dressing of stable manure. I was raised on a farm and have had twenty years of experience in California and southern Oregon as a farmer and orchardist, and in a lifetime of over fifty years I have never seen finer vegetables grown than I have grown here. I have grown tomatoes to maturity, but not ripening in open culture. I have found no trouble to mature Burbank and Snowflake potatoes of the choicest quality.

Strawberries and small fruits are simply perfect, and, in localities sheltered from the winter winds, I fully believe hardy cherries, plums, pears, and apples of early varieties could be successfully grown.

Yours, very truly, W. P. Benn.

TOO MUCH RAIN AT YAKUTAT.

YAKUTAT, ALASKA, *October 14, 1902.*

DEAR SIR: I regret to say that this has been a bad season, as the spring was very late and seeds could not be planted before May, and since the middle of July it has been raining incessantly, thereby rotting such vegetables and grain as were in the ground. I used seaweed for fertilizer, and the ground is a sandy loam. I planted the seed the 15th and 16th of May, with the following results, viz: The asparagus, cucumbers, and rhubarb did not grow at all. Windsor beans and peas grew well at first, but rotted later on account of too much rain. Beets, cabbage, cauliflower, and carrots grew well at first, but continued rains stopped their growth. Kale and parsnips grew well. The lettuce, radishes, and mustard were a success. The onions and spinach grew very little; turnips and ruta-bagas grew well at first, but were very small. Red, white, and alsike clover grew very poorly owing to the fact that it was late in the season and they died from too much rain. The barley, wheat, oats, and grasses were planted in the sand on Kantaag Island, as I did not have room for them in the garden, and they grew very little. The potatoes generally grow well here, and I think almost all vegetables could be raised successfully, providing one could give them the proper attention.

Very respectfully, R. W. BEASLEY.

CROPS RAISED BY AN INDIAN.

ELLAMAR, ALASKA, *October 8, 1902.*

DEAR SIR: I gave some of my seeds to an Indian, as I had to make a trip to Dawson and could not get back in time to plant them. He raised very fine radishes, turnips, lettuce, and potatoes. The largest turnip was 5 inches across the root. I did not know the name of the potatoes, as I bought them in a store here, but they were crisp and fine, but not mealy. I gave the native instructions how to plant them and showed him where to plant them. The yield was large.

Yours, truly,

JOHN M. DE HART.

GOOD GARDENS ON PRINCE WILLIAM SOUND.

BLIGH ISLAND, PRINCE WILLIAM SOUND,
Ellamar, Alaska, October 1, 1902.

DEAR SIR: As requested, I send you a report of our experiments. The report includes Mr. Cloudman's and the undersigned. Both of us are located on the above island, about 3½ miles apart, and both locations have an east and south exposure. Mr. Cloudman's soil is peaty, while mine is a black loam, and where the garden is planted has been under cultivation for five years. Mr. Cloudman's land has been under cultivation for four years.

Beans (Windsor) planted late made a growth of 4 feet and blossomed freely, but bore no beans. I think if they had been planted earlier they would have done better, as the latter part of the season was very wet.

Beets (Early Egyptian) were planted in rows 18 inches apart and about 8 inches apart in the rows. When well up, I gave mine a good dressing of burnt clam shells (powdered) close to the plants. They did splendidly, and several will measure 6 inches in diameter. Carrots I did not plant, but have grown them here to a good size.

Cabbage (Jersey Wakefield) was planted in a box March 28, and kept in the house until they were transplanted, May 30, in rows 2 feet apart and about 20 inches apart in the row. I had to thin them out later in the season. They made good, solid heads, some weighing 8 and 9 pounds. We were unsuccessful with cucumbers.

Lettuce, radishes, and mustard did well. Onions made a very fine showing. Parsnips did well and were of a fine flavor. The peas (American Wonder) which I planted were destroyed by birds. Mr. Cloudman had some that did well. Rhubarb does well here. I have raised it in the past four years. Turnips of all kinds did extra well. They were planted in rows 20 inches apart, and when well up were thinned out to about 8 inches in the rows. Some of the earlier varieties were left thicker, and thinned out as wanted for the table. One of the Golden Ball turnips weighed $7\frac{1}{2}$ pounds, was solid, and of splendid flavor. Ruta-bagas made good growth. Potatoes did splendidly, both the Early Rose and Burbank. Mr. Cloudman had one hill of Early Rose that weighed $11\frac{1}{2}$ pounds. He sold over 1,200 pounds of potatoes this season at $3\frac{1}{2}$ cents per pound. I estimated Mr. Cloudman's crop of potatoes this year at 3,000 pounds. We used seaweed as a fertilizer. It was gathered in the fall and piled up in the garden and spaded under in the spring. I do not know how much it would weigh to the acre, but it was applied very liberally. Wood ashes and burnt clam shells were also used. The clover and grass seeds were planted in new ground outside of the fence. The chickens kept them from making much of a growth, but I believe they would be all right here. Timothy I have raised for several years, and it does well.

Yours, truly, W. J. Busby.

NOTE FROM A PIONEER.

Gage Island, Alaska, *October 4, 1902.*

Dear Sir: I have this day finished gathering my vegetables. Potatoes did well; fairly large and good yield of crop. Turnips are very large and solid. Ruta-bagas are good. Carrots are small. Parsnips are very small. Radishes are very large and brittle. Lettuce grew large and tender. Cabbage has fairly large and solid heads. Kale grew very large. Peas will not mature here on Gage Island. Cucumbers will not grow to success. Beets have done very poorly. Onions are small, but good for sets next year.

I have been raising garden vegetables for three years here for my own use. I find with a little work that any of this ground properly broken up and pulverized with any kind of fertilizer mixed in will grow good vegetables. The best cabbage I have is raised on ground that was broken on a grass flat, which took two years to rot and get in proper shape for tilling. The seasons are very late here, as Gage Island is close to a large glacier. June 1 is the earliest I have ever planted seeds, while this year it was June 4 and 5.

Yours, respectfully, G. W. Flemming.

LETTER FROM VALDEZ.

Valdez, Alaska, *October 13, 1902.*

Dear Sir: Circumstances prevented my making use of the seeds sent me in the early spring, and it was the end of May before I made a start. We had a comparatively dry spring, which necessitated considerable use of the watering can until the end of July. From then to date of writing, say twelve weeks, we have only had about six fine days. Notwithstanding the extreme humidity my garden has been a source of pleasure and profit, as well as a delight to strangers coming to town. In regard to vegetation, they expected to see little, and they were agreeably surprised to find that the useful hardy vegetables looked as well and in most cases tasted better than anything raised in the most favored localities.

As this is my third season, I knew just what seeds to sow in my limited patches, and have to report only two failures, viz, turnips and cucumbers. The former, after

making rapid growth for a few weeks, were attacked by a worm, which cut away the roots and destroyed the plants. I afterwards sowed ruta-bagas in a patch about 100 feet away, and they have done very well. So, whether it was that the worms affected that particular spot or have an aversion to the ruta-baga's flavor I can not say, but will try to find out on a future occasion. The cucumbers were fine, healthy plants and showed great promise until the cold rain came. I think if the seed had been sown a month earlier we would have had a crop suitable for picking. Among the vegetables which were a success would particularly mention spinach, cabbage, kale, carrots, beets, radishes, lettuce, and parsley. Potatoes have done well. I was planting till well on in July, so have been regaled with new potatoes for several months. Peas did all we could wish during the fine weather. Had they been sown earlier the crop would have been abundant, and as it was, the few messes we gathered were so delicious that I was more than compensated for the trouble taken.

Yours, truly,

JAS. FISH, JR.

FEEL HIGHLY ENCOURAGED.

HALIBUT COVE, VIA HOMER, ALASKA, *September 15, 1902.*

DEAR SIR: As I am about to leave for the States, I am forwarding you an early report of the success of the seeds you so kindly sent.

The ground was not prepared until late in May. We used no fertilizer and had dry weather for two months after seeding. The flowers did well, especially the nasturtiums, sweet allysum, pansies, and sweet williams. Of the garden vegetables, the radishes, ruta-bagas, Brussels sprouts, carrots, parsley, and cabbage have all done well. We also put in some potato parings and potatoes, and, strange to say, plants from the parings have grown nicely. Considering all, we feel highly encouraged for the next season. Next year we shall prepare most thoroughly and use seaweed as fertilizer. The soil is alder bottom.

Respectfully, FRANCIS X. WALDRON.

GRAIN RIPE BY MIDDLE OF AUGUST.

KENAI, COOK INLET, ALASKA, *August 24, 1902.*

DEAR SIR: I am having great success with my vegetable garden this summer. Last spring I seeded potatoes, cabbage, ruta-bagas, turnips, radishes, lettuce, peas, etc. I sowed Manshury barley and Burt Extra Early oats on May 7, in light sandy soil, which were ripe by the middle of August. I also sowed some flower seeds, and have my house decorated with flowers. Thanking you for the favor in sending seeds, I remain,

Yours, respectfully, ED. EDELMANN.

REPORT FROM HOPE.

HOPE CITY, ALASKA, *July 28, 1902.*

DEAR SIR: We received and distributed the vegetable and flower seeds sent us this spring.

The white-flesh ruta-baga seed, sent us in 1901, we have sown and find the ruta-bagas are very small, with many branch roots, and not well liked by the public.

The season of 1901 was dry up to July 3, and rather cold all season. Everything matured rather late, but everything turned out unusually well. The first frost set in about middle part of October.

Only about 12 strawberry plants of the 50 we had growing last summer came to life this spring. The small plants are doing well now, and we had ripe strawberries

on July 20. The best berries measured $4\frac{3}{4}$ inches in circumference and weighed one-half ounce troy weight. Gooseberries planted in 1901 were all alive this spring, and have made a rapid growth up to this date. Our fruit trees, planted in 1901, such as apples, plums, and cherries, were killed by last winter's frost. Pear trees have started to grow again just above the ground. This spring we have planted only one Bismarck apple tree from Michigan, and it is growing nicely; also have planted strawberries from Michigan.

White Dutch turnips, sown May 17, were ready for the table July 10. We believe that the Early White Milan is earlier than the White Dutch. We have had peas ready for the table this year July 17. Cabbage is also ready for the table at this date, and so are beets. Potatoes will be ready for the table by the 1st of August.

Everything was from 10 to 14 days earlier than any previous year. We have had a very dry, warm summer, and the first rain of any consequence, after the snow left the ground, fell on July 22.

Yours, truly, Roll Bros.

GARDENING AND POULTRY RAISING SUCCESSFUL AT KADIAK.

Kadiak, Alaska, *October 18, 1902.*

Dear Sir: I desire to say that a certain class of vegetables, including potatoes, are a success in Alaska. I planted quite a large garden; its equal I have never raised nor seen in the States. Radishes, onions, lettuce, beets, parsnips, cauliflower, peas, turnips, ruta-bagas, and carrots were the best-flavored and the largest I ever raised. Cabbage is excellent. Potatoes are immense, for size and yield, and of most excellent flavor.

They told me I could not raise anything. A number of families received vegetables from my garden during the summer. They told me poultry was not a success, and I tried it in a small way. On December 10, 1901, I selected from a lot of chickens 21 hens and 1 rooster. The hens were a mixture. They commenced to lay and we sold the first eggs at Christmas time at 50 cents per dozen, which price continued throughout the year. Sold from the date mentioned to September 15, 1902, $113\frac{1}{2}$ dozens of eggs, during which time I had 12 hens to hatch and raised 100 chickens. I have sold from the lot $34 worth of chickens. Have used several chickens for family use, and have 45 left. During the time mentioned my wife used what eggs were wanted for household use. The chickens are healthy and I feed them well. The feed used during the time cost $27. I used wheat, bran, plenty of red pepper, boiled potatoes, together with turnips thickened with bran. This makes a healthful food for chickens, and helps them to molt, and is excellent for laying hens.

Yours, truly, L. L. Bowers,
Deputy United States Marshal.

TREES FAIL AT KARLUK.

Karluk, Kadiak Island, Alaska,
April 13, 1902.

Dear Sir: Some two years or more ago I obtained a nice lot of Norway spruce and set them out in ground prepared for them. They were getting on nicely when our hares discovered them and soon made short work of them. Some five years ago I obtained a hundred American elms from Connecticut. The spring following they were found to be lifted clear out of the ground by the frost and were standing on tiptoe, as it were. The lesson from this experiment would indicate that it was very necessary to mulch, and to do it thoroughly. We replaced them and a portion of

them lived for some three years, but made scarcely any growth or headway, and finally all died. Last year I obtained some blackberries and currants (plants).

Rhubarb, English turnips, radishes, and spinach did splendidly. Red clover and timothy I have tried and they do well here. We found that horse-radish and parsnips grow freely enough, but are a mass of fine roots. Beets go to seed at once. Cabbages go to tops. Planted cress, but it never came up.

Sincerely, James A. Richardson.

EVERYTHING DID WELL.

Afognak, Alaska, *October 17, 1902.*

Sir: In regard to the seeds would say that we had a very favorable season this year, and everything that I planted did well. I had one cauliflower weighing 6 pounds. The potato crop was about double that of last year, owing to the fact that I mixed kelp with barn manure, according to your suggestion. Oats and barley ripened.

Yours, truly, Emil Christensen.

A GARDEN ON SEMINOVSKY ISLAND.

Unga, Alaska, *August 3, 1902.*

Dear Sir: A few days ago I returned from the island of Seminovsky, where Mr. J. C. Smith lives. I had heard so much about the agricultural possibilities of that place that I was very anxious to see them for myself. Mr. Smith has a garden covering about one-half an acre, and it is in fine condition. The soil is not so heavy as on the other islands of the Shumagin group, and on the spot where the garden is formerly was an old settlement. I dug around there, and to the depth of about 8 feet found decayed fish and decomposed bones, etc. This partly accounts for the good results of the garden, but the chief reason of its success was the way it was attended to. It is kept as clear of weeds as possible, and not planted too closely together, and worked sufficiently. The cabbage, potatoes, beets, turnips, etc., are as nice as I ever saw anywhere.

He also has a nice herd of cattle, and altogether it is an ideal place, where plenty reigns. He asks me to write to tell you about it, and I take pleasure in doing so. He is very anxious to plant some blue-grass seed, and I promised that you would send him some. He complains that his cabbages, when they reach a certain size, break open.

Respectfully, yours, T. A. Golder.

JUST GETTING INTERESTED.

Sanak Island, Alaska, *September 4, 1902.*

Dear Sir: I have tried turnips, radishes, carrots, beets, kale, and cabbage. The first year I just turned up the ground and planted the seed, and it did not succeed very well. The second year, after having put on some stable manure, I raised some very fine radishes and turnips. Potatoes grew fairly well. I am just getting interested in the business now and am going to give it a good trial next year. I haven't had much time so far, but there are several settlers here who are going to take it up and see what can be done. I am almost certain that the ground will answer well for agricultural purposes.

Respectfully, yours, Paul Hansen.

GRASS GOING TO WASTE.

SANAK ISLAND, VIA SAND POINT, ALASKA, *September 7, 1902.*

DEAR SIR: The seed I got last year I distributed among the natives here, and they planted some of it. The turnips and radishes turned out fine, but the rest of the seed they would not bother with, as it was too much trouble. The country around here is one of the greatest grazing lands that I have ever seen, and I think in time it will be taken up for cattle; and anyone who is interested in the opening up of this part of the country should advance that interest first, and the rest would follow without trouble. On Sanak Island there are 40 head of cattle, owned by four parties, and on the other islands more or less, but so far there has been no market for them. As soon as there is a possibility of a market for beef the country will boom, and the first will make a haul. There are thousands of acres lying idle with the finest kind of grass going to waste, and the climate is mild enough for the cattle to remain out most of the winter, as they do on Sanak. If we had a market, the people up here could tend to their homes and raise all kinds of vegetables, and even grain, besides cattle. Farmers and cattlemen would flock in from all parts, and fox breeders could use the same island for a cattle ranch and farm. However, I suppose it will not be in our time. I must say that it would be an Eden for some farmers, as the ground is mostly level and the soil rich with millions of tons of manure, that is, kelp, an eelgrass, around the beaches. There are all kinds of berries growing wild, and the water teems with fish of all kinds. I have lived here now close on twenty years, and I love the place.

Yours, truly, ANDREW GROSVOLD.

POULTRY ON THE NUSHAGAK.

Rev. S. H. Rock, of the Moravian mission on the Nushagak, writes me as follows about his poultry: "I must not forget to tell you how well my hens are doing. Since January 1 they have not stopped laying, and since that date until the present (July 3) they have laid 75⅓ dozens of eggs. I have 13 hens, and 8 of these did not begin to lay before February and March, because they were young hens, hatched late last summer. I never saw hens look more healthy than ours do. In the coldest weather in the winter, when hens usually sit with their heads under their wings, ours were lively and busy. We used eggs moderately, of course, but we sold about $12 worth to our neighbors, and gave quite a few to such as were in need of them."

He adds further: "The white settlers are one and all starting gardens, and they raise principally potatoes, but other vegetables also. They are poor writers, they say, and I guess they do not acknowledge the seeds, but I have often heard them say that they are thankful for the seeds the Government sends them."

DID NOT DO WELL.

COPPER CENTER, ALASKA, *September 30, 1902.*

DEAR SIR: My observations this year convince me that an experienced man can raise any hardy variety of vegetables in the Copper River Valley.

On April 15 I planted curly kale and spinach in seed boxes, putting them out in the sun in the daytime, and until May 8 I kept them in the house at nights, and after that date the boxes remained in the open air both day and night. The plants from this seed were transplanted June 6. The kale grew to good size and the spinach went to seed before the plants were fully matured.

On June 3 the frost was out of the ground, and I then selected a spot where several large cabins had been burned. The soil was sandy and mixed with ashes and charcoal. I covered the soil with 3-year-old manure, dug it under, and put in the seeds. Planted carrots, lettuce (Red Simpson, Green Simpson, and Deacon), and radishes June 4. The carrots never grew to any size; the lettuce, however, did very well, excepting Deacon. The Curly Red Simpson did best. Radishes suffered from a red bug. Lettuce and radishes were up in five days.

Planted peas June 5 in a bed that had been worked in 1901. Gave light covering of manure, dug spade deep, and on June 12 the peas showed overground. On July 4 they were in blossom, and August 1 I picked some pods and found the peas fully developed. At the present date they have thrown out new runners, which are in blossom. The peas were never irrigated, and we had no rain to speak of the entire summer. The varieties planted were as follows: American Wonder, Alaska, Thorburn Extra Early. The first two varieties did best.

Planted carrots June 6. The soil was so full of ashes and precipitation so little that the wind would shift the soil. Did not mature. Planted spinach June 7, which did well; parsnips planted same day, but these did not get large enough to use. June 9 planted cabbage (Early Jersey, Wakefield, and Drumhead), mustard (White London), Brussels sprouts, cauliflower (Extra Early Snowball). At present date, September 10, cabbage is just heading. Brussels sprouts barely show the buttons; cauliflower has formed heads; the mustard did well.

I also planted turnips (Whitetop and ruta-bagas) broadcast, but too thick to do any good. As both have been successfully grown here the year previous there is no doubt that they will do well.

Yours, truly, F. W. Rosenthal.

GRASS AND GRAIN ON THE CHISNA.

Chisna, Alaska, *September 7, 1902.*

Dear Sir: We inclose under separate cover samples of timothy and clover (alsike) sown in this locality on July 6, 1901. The ground was not prepared, but the seed was sown broadcast over the tundra and grasses that cover the lowlands of the Chisna Creek.

The timothy was noticeable last year, and the present year it ripened two weeks before the frost came. This has matured at an altitude of 3,200 feet at this place and 4.500 feet at a point 8 miles up the Chisna.

Blue grass was sown at the same time, but I could not find a sample of sufficient growth to forward for your inspection. We also planted peas, beans, wheat, oats, barley, and radishes; also onions, lettuce, and turnips in the locality of the Chisna post-office. Had the horses not nipped the oats, wheat, and barley they doubtless would have matured. The vegetables above named would do well under favorable attention.

From the inspection of what we have sown and planted, we are of the opinion that oats, barley, and timothy will do quite well—timothy in particular.

Very respectfully, yours,

Hazelet and Meals,
Of the Chisna Mining and Improvement Company.

GARDENS ON THE YUKON.

Nulato, Alaska, *September 22, 1902.*

Dear Sir: The five packages of assorted seeds which I received from the Department in the summer of 1901 were distributed to Mr. George Perrault, Bishop

Mountain, 30 miles above Nulato, on the south bank of the Yukon; to Corpl. Joseph R. Randolet, U. S. Signal Corps, Narardotilten, 45 miles above Nulato, northern bank of the Yukon; to Mr. Edward Keogh, Kantotsitsten, 55 miles above Nulato, on the north bank of the river; to Mr. Richard Motschman, in the same locality, and one package was kept and used at the mission in Nulato.

I visited the gardens during the summer, except that of Mr. Perrault, and found them quite satisfactory. Mr. Perrault reports that he had not as good success as he anticipated, though he carefully prepared the ground, burning the stumps and brush. He attributes his partial failure to the fact that the ground was altogether new, and he expects better success next year, the soil being now loose and thawed. However, the radishes, ruta-bagas, and lettuce have given full satisfaction.

Corporal Randolet sowed his seeds in several patches, on the best exposed points around the telegraph station. The patches of cultivated soil almost disappeared amidst the rank grass that surrounded them, and made very little show on the ground. The growth, however, was good, and the vegetables came out very nicely.

Messrs. Keogh and Motschman were under better circumstances, being able to avail themselves of a large patch already cleared, and tilled in previous year.

This garden was quite a success, having a variety of vegetables which I have not seen equaled except in our mission gardens, which are on a rather large scale. Besides the ordinary radish, ruta-baga, and lettuce, there were beans and peas, carrots and parsnips, all in very good shape when I passed. The cabbage, however, did not seem to prosper as well as the other plants.

In the mission garden all the above seeds have given full satisfaction. Potatoes have succeeded remarkably well this season. About 30 bushels were dug from our garden, and their size and quality are by far above that of the preceding years. The barley which you gave me for experimenting was sown, part along the southern side of the residence on a narrow strip of good soil in an exceptionally well-exposed situation, and part in the garden, without special protection. Only the former matured; the latter did not harden, though the season has been remarkably long and warm.

Very sincerely, yours,

[Rev.] Julius Jette, *S. J.*

HOLY CROSS GARDENS BETTER THAN EVER BEFORE.

Holy Cross Mission, Koserefsky Post-Office,
Yukon River, Alaska, September 23, 1902.

Dear Sir: Our gardens have beaten the record for ten years. The potatoes are large and better quality than usual, especially those from seed sprouted in soil before planting in the garden. The largest turnip, Flat Dutch, weighed about 16 pounds. The Yellow Globes did well also. We had green peas in abundance, and beans for the first time. Our radishes and lettuce found a ready sale on the boats. Berries grew in profusion, and almost everybody has a good supply for winter.

Some of our more intelligent natives are trying to start gardening and are receiving substantial encouragement from the mission.

Respectfully, yours, J. V. O'Hare, *S. J.*

SEEDS ARE VALUED—TANANA FARM LANDS.

Rampart, Alaska, *August 1, 1902.*

Dear Sir: Please permit me to thank you for the supply of garden and grass seed, which came to hand some weeks since, and all of which have been carefully planted, although put in very late. I am located across the divide on the Tanana slope, where there is an untold acreage of the finest farm land imaginable. More gardens

have been planted here this summer, by far, than ever before, but not one-hundredth of what should be planted. No seed is to be had except what is supplied by the Government, and the encouragement to farming and gardening will prove a good investment.

Sincerely, yours,

E. J. TOWNSEND.

ON THE YUKON.

RAMPART, ALASKA, *July 2, 1902.*

DEAR SIR: The present season so far promises to be the most favorable for gardening of any for six years. Spring came early, with steady, fine, warm weather about the 1st of May. June was hot and dry, and vegetables needed a good deal of watering to give them a good start. The last two weeks have brought plenty of rain.

Cabbage, kale, cauliflower, ruta-bagas, beets, turnips, and lettuce are well advanced and look as healthy and strong as those grown under the most favorable circumstances of soil and climate. Radishes did not grow as crisp and tender as in former years, probably due to the hot sun shining on them from eighteen to twenty hours daily. Peas did not come up well; only about one-tenth of the seeds sprouted. They are in bloom now. All of the above seeds were planted in ground that had been under cultivation from two to five years, were well taken care of, but, with exception of the potatoes, had no manure or fertilizer. This is my third attempt to grow potatoes. Twice the frost killed them, in 1901 on July 30 and in 1900 on August 16.

Respectfully,

JNO. A. CLINTON.

STRAWBERRIES SURVIVE WINTER AT DAWSON.

DAWSON, ALASKA, *July 3, 1902.*

DEAR SIR: The oats which we planted this year on old ground look as if they were going to do much better this summer than last. The spring was much later this year. We planted a few strawberries last year in July just for an experiment. They lived through the winter nicely and now have quite a supply of good-sized berries on them. We put them in sandy soil and put lots of ashes around them.

Yours, sincerely,

J. A. MORGAN.

GARDENING AT COLDFOOT, ONE HUNDRED MILES NORTH OF THE ARCTIC CIRCLE.

DEAR SIR: We are located about 100 miles north of the Arctic Circle, near the headwaters of the Koyukuk River. Last year I had very good success with radishes, lettuce, turnips, and cabbage, although the cabbage did not come to head, yet it grew so rapidly that the leaves were tender and of fine flavor. I pulled the cabbage after the first light snow and hung it up and let it freeze. Have only used the last a few days ago, and it was as good as in the early fall. Have turnips yet, and they are all right. I think that my success with gardening last year will induce a number of other people to try it this year. It will be a great help to the community if all would raise a few of the vegetables mentioned, should we not succeed with other varieties, and will do much to promote good health, as we are in such an isolated locality that it is almost impossible to get any fresh vegetables, and when we do, the expense is very high. Last summer I paid 45 cents per pound for potatoes.

Yours, truly,

D. A. MCKENZIE,
United States Commissioner.

COLDFOOT, ALASKA, *September 1, 1902.*

MY DEAR SIR: This was a dry season, the driest in four seasons I have been in Alaska, but I have had fairly good success with my garden this year. The radishes, lettuce, and turnips were a perfect success; also the cabbage looks very healthy at this writing, and I believe fairly developed heads will appear. The onions raised from sets did nicely; the turnips—if I had any way of sending one to you, would certainly do so—the largest I should judge would weigh 4 pounds. I do not want to pull them yet, as I want to give the largest show possible; later I will send their weight.

I am satisfied that with a little investigation and study vegetables can be produced in this country that will satisfy the demands of the population. If we could only secure fresh potatoes, I have no doubt they would make a fairly good crop, but the trouble is the potatoes we receive are two years old when they are planted, consequently do not thrive. We can not raise onions from the seed, but if we could get onion sets we could supply ourselves with green onions.

It seems that the success of gardening rests entirely on the proper soil and then giving it proper attention. The ground that I prepared last year produced at least four times the amount of vegetables that the new ground produced. Sandy soil, worked very thoroughly, with plenty of wood ashes and horse manure, if it can be secured, seems to produce the best results. I shall extend my ground next spring so that I will have about an acre.

We have an abundance of some varieties of wild berries in this section of the country that are a great help in the food line. Blueberries grow in abundance; also the low bush cranberry, a very delicious berry when preserved; also the wild currant. I believe the domestic currant would thrive here, and perhaps some other small fruits, if we could only manage to get the sets in here for a starter. In fact, there is far more that can be accomplished in this northern country than would be imagined possible by people who have not investigated the subject.

Yours, respectfully,

D. A. MCKENZIE,
United States Commissioner.

FROM THE SHORES OF THE ARCTIC OCEAN.

POINT HOPE, ALASKA, *August 10, 1902.*

DEAR SIR: The seeds which you sent reached me a few days since, but I will not be able to plant them until next year. I have already planted twice this season, once on June 15 and again July 9, but can not at present report results. I will do so later on.

The radishes appear to be the only vegetables that will mature. They were planted June 15, and I expect that if no frost comes they will have sufficiently matured for use by the beginning of September. The peas have come up, but are quite small, and do not look as if they will amount to anything. Some of the other seeds have not made any sign of coming up. I am afraid that the ground is too cold.

Yours, very truly,

[Rev.] JOHN B. DRIGGS.

GARDENING IN NORTHERN ALASKA.

The Crop Reporter for the month of September, 1902, issued by the United States Department of Agriculture, contains an article by Mr. Middleton Smith, which is of special interest because of the author's experience in the north. Mr. Smith was

employed as a naturalist on the International Polar Expedition, to which he refers. An extract from this article follows:

"Probably the first experimental gardening in Alaska, north of the Arctic Circle, was done by the International Polar Expedition to Point Barrow, Alaska, 1881–1883, which was organized for the purpose of cooperating in the work of circumpolar observation proposed by the International Polar Conference. The main object of the expedition was the prosecution of observations in terrestrial magnetism and meteorology. Experimental gardening was an elective investigation.

"The arctic night at Point Barrow, which is of seventy days' duration, ends at noon on January 23, when the upper edge of the sun's disk appears above the southern horizon. The day continues to lengthen and night to shorten until the middle of May, when the midnight sun appears above the northern horizon and the long arctic day begins. The sun then remains above the horizon both day and night for seventy days, or until July 24, when it dips its lower disk at midnight below the northern horizon, and night and day again begin.

"The snow does not begin to melt until after the sun remains continuously above the horizon and does not disappear before July, but the land close to the coast is practically free from snow by the 5th of June. The snowfall is very light, the depth on the land along the coast at no time exceeding 15 or 18 inches. The total annual precipitation—rainfall or melted snow—is only 8 inches.

"A level, treeless area (tundra) occupies the entire Point Barrow region. The subsoil, principally sand and gravel, perpetually frozen, is covered on the tundra generally by a light, clayey soil, and at spots near the coast by a dark, loam-like soil, which thaws to a depth of from 3 to 9 inches. Upon the latter soil, within 200 yards of the ocean water line, the gardening was done. The soil has been enriched somewhat by refuse from Eskimo igloos, or permanent dwellings, which many years previous existed there. The garden was dug to the depth of about 4 inches and raked. No other preparation of the soil was made, and no further attention was given to the garden from the time of seeding to harvest day.

"On June 13 the seed of lettuce, radish, and mustard were sown. By this date caterpillars, worms, flies, and beetles appeared; ranunculus flowers were in bloom. June 21, 1 day before the sun reached its highest altitude and 8 days after the date of seeding, the lettuce and radish germinated, but the mustard failed of germination. By this date additional species of flowers, including the daisy and willow, were in bloom, and the pools of fresh water, which had formed on the tundra from rain and melted snow, were fairly alive with insect life.

"On the tenth day of July, 27 days after seeding and 19 days after germination, harvesting began. The lettuce leaves were from 1 to 2 inches in width and from 3 to 4 inches in length. The radishes, spherical in form, were from one-half to 1 inch in diameter. The condition of these vegetables at the time of harvest was perfect. The quality could not be excelled by any grown anywhere in the lower latitudes, Antarctica by inference excepted.

"During the nineteen days required for the crops to mature the minimum temperature was 32° or below for 9 days. The maximum temperature was 50° or above for 3 days only. The mean daily temperature, from hourly observations, ranged from 30.92° to 53.35°, the general average mean for the entire time being 38.16°. The total precipitation was 0.13 inch. There were 4 clear, 5 fair, and 10 cloudy or foggy days.

"A study of the conditions under which the plants germinated and matured is not only curiously interesting, but suggests that there was some stimulating force—perhaps the large amount of atmospherical electricity—which caused them to arrive at maturity in a much shorter period than those grown in temperate zones. Whatever the agency, inasmuch as the summer season is so very brief, it is absolutely necessary that plant life in the north should arrive at maturity very quickly in order to perpetuate the species."

A COLONY OF FINNS TO BE LOCATED ON KENAI PENINSULA.

Messrs. Hornborg & Co., who operate a steamship line between Finland and New York, have made arrangements to bring out a colony of Finns the coming spring and locate them in Alaska. The Finlanders are at present leaving their native land in great numbers, and the climate of Alaska being similar to that of Finland, they naturally desire to locate there. The place which has been selected for the settlement is on the southern end of the Kenai Peninsula, on Katchamak Bay, which is bordered by a large tract of land that appears promising for agriculture. The bay is large; it affords excellent shipping facilities; some large streams empty into it which abound in fish, and the neighboring mountains are well stocked with game. The selection seems to be a favorable one from all points of view.

In response to a letter of inquiry which I sent to a member of the company I received the following reply:

HOMER, ALASKA, *September 26, 1902.*

Prof. C. C. GEORGESON, *Sitka, Alaska.*

DEAR SIR: I have just completed all that can be done this season in the way of arranging for the bringing to the upper part of the bay our Finnish colony, and am now on my way to New York.

The necessary lands for landing and caring for the immigrants while their houses are being put up have been surveyed, and a location on the highland on the upper western shore of the bay decided on. The landing place will be at Bear Cove, on the eastern side, as there the water is deep. The stock and immigrants can be carried over in scows from that point.

The coming spring we do not propose to locate more than 20 or 30 families, as we wish to have some here for a year before bringing out a large number, in order that they may get off one crop and we be assured that we have made no mistake in the selection of the Kenai Peninsula for a colony site.

We know that you are interested in the success of the experiment and shall feel indebted to you for any aid you may give by advice as to treatment of soil, crops, etc., and for the necessary seeds for the first year's planting.

The families will arrive here in early May, so they can plant their crops by the end of the month or the first of June.

Very truly, yours,

E. S. CHURCHILL,
Director Alaska Colony Company.

This appears to be a commendable enterprise. Alaska will be the gainer by the planting of such colonies, and she has unlimited room for them. Of all northern peoples who may find Alaska congenial there are none who will surpass the Finns as pioneers. They are a hardy, industrious, and law-abiding people. They are familiar with the climate and the methods of culture which must be adopted. They are excellent farmers, dairymen, and stock raisers.

Finland lies in the same latitudes as Alaska, and although it has but one-fourth the area of Alaska it has a population of 2,600,000. Out of this total only about 300,000 live in cities; the rest live in the country and small villages, and a large majority of them are farmers. If Alaska could secure a large immigration of Finns, the development of the Territory would be assured.

THE SOIL TEMPERATURES.

I submit herewith a record of the soil temperatures at the stations at Sitka, Kenai, and Copper River, the latter for but little over two months, however; also the record for August and September at Eagle during 1901. The two soil thermometers are planted 6 inches and 24 inches deep, respectively. The radiation thermometer is simply an ordinary minimum thermometer, which is suspended 6 inches above the surface of the soil, and therefore gives the minimum temperature as the vegetation feels it.

Soil temperatures.

SITKA EXPERIMENT STATION.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1902.	°F.	°F.	°F.	1902.	°F.	°F.	°F.	1902.	°F.	°F.	°F.
May 1	43.5	40.5	....	July 2	56	52	44	Sept. 2	53	52.5	45
May 2	44	40.5	36	July 3	55.5	52	47	Sept. 3	53	52.5	46
May 3	43.5	41	30	July 4	55	52	47	Sept. 4	52.5	52	46
May 4	44	41	29	July 5	55	52	43	Sept. 5	52.5	52	46
May 5	45	41.5	29	July 6	55	52	40	Sept. 6	52	52	42
May 6	44.5	41.5	29	July 7	55	52	40	Sept. 7	51.5	52	44
May 7	45	42	30	July 8	56	52	41	Sept. 8	52.5	51.5	48
May 8	46.5	42	30	July 9	57	52.5	50	Sept. 9	54	51.5	47.5
May 9	47.5	42.5	33	July 10	57	52.5	40	Sept. 10	52	52	45
May 10	46.5	42.5	36	July 11	56	52.5	40	Sept. 11	52	51.5	44
May 11	46.5	42	36	July 12	57.5	52.5	50	Sept. 12	53	52	45
May 12	46	43	31	July 13	56.5	52.5	48	Sept. 13	51	51.5	35
May 13	46	43	31	July 14	55	53	45	Sept. 14	51	51.5	40
May 14	46	43.5	31	July 15	50.5	53	40	Sept. 15	50	51	34
May 15	47	43.5	31	July 16	56.5	53	47	Sept. 16	50	51.5	41
May 16	48	43.5	38	July 17	56.5	53	50	Sept. 17	55	51	41
May 17	47.5	44	37	July 18	56.5	53	51	Sept. 18	49	51	37
May 18	47.5	44	38	July 19	57	53	52	Sept. 19	49	50	38.5
May 19	47	44.5	38	July 20	57.5	53	52	Sept. 20	49	51.5	39
May 20	47.5	44.5	40	July 21	57	53	49	Sept. 21	49	51	40
May 21	47	44.5	37	July 22	57	53	48	Sept. 22	50	50.5	41
May 22	46.5	44.5	35	July 23	56.5	53	50	Sept. 23	49.5	50	40
May 23	47.5	44.5	35	July 24	56.5	53	50	Sept. 24	48	50	36
May 24	48	45	43	July 25	56.5	53	50	Sept. 25	49	50	41
May 25	48	45	38	July 26	56.5	53	49	Sept. 26	48	50	41.5
May 26	48	45	34	July 27	56.5	53	45	Sept. 27	48	50	39
May 27	47.5	45	32	July 28	56.5	53	50	Sept. 28	49	49.5	42
May 28	47.5	45.5	38	July 29	56.5	53	47	Sept. 29	49	49.5	44
May 29	47.5	45.5	41	July 30	57.5	53	48	Sept. 30	50	49	41
May 30	48.5	45.5	36	July 31	58.5	53.5	50	Oct. 1	51	49	46
May 31	47.5	45.5	39	Aug. 1	59	53.5	52	Oct. 2	51	49	45
June 1	47.5	45.5	32	Aug. 2	58.5	53.5	51	Oct. 3	51	49	45
June 2	49	46	38	Aug. 3	58.5	53.5	50	Oct. 4	51	49.5	44
June 3	50.5	46	38	Aug. 4	57.5	54	50	Oct. 5	50.5	49.5	46
June 4	51	46	41	Aug. 5	57	54	52	Oct. 6	51	50	46
June 5	51.5	46.5	40	Aug. 6	56.5	54	51	Oct. 7	52	50	47
June 6	51.5	46.5	45	Aug. 7	56.5	54	50	Oct. 8	51	50	46
June 7	51	47	43	Aug. 8	57	54	42	Oct. 9	51.5	50.5	46
June 8	51	47	43	Aug. 9	57.5	54	51	Oct. 10	51	50	46
June 9	51.5	47.5	44	Aug. 10	57	54	48	Oct. 11	51.5	50	36
June 10	51.5	47.5	44	Aug. 11	56.5	54	45	Oct. 12	50.5	50	36
June 11	51.5	47.5	44	Aug. 12	56	54	48	Oct. 13	49	50	34
June 12	51.5	48	45	Aug. 13	56.5	54	50	Oct. 14	48	50	34
June 13	51	48	45	Aug. 14	55	54	45	Oct. 15	46	49	34
June 14	52	48	38	Aug. 15	55	54	41	Oct. 16	47	49.5	38
June 15	53	48	38	Aug. 16	55	54	45	Oct. 17	46	49	33
June 16	54	48.5	41	Aug. 17	55	53.5	48	Oct. 18	45	49	34
June 17	54	48	37	Aug. 18	55	53.5	48	Oct. 19	45	48	25
June 18	54.5	49	42	Aug. 19	55	53.5	44	Oct. 20	43	48.5	31
June 19	55	49	40	Aug. 20	55	53.5	41	Oct. 21	45	48.5	34
June 20	55	49	38	Aug. 21	55	53.5	45	Oct. 22	45	48	35
June 21	56.5	50	42	Aug. 22	55	53.5	44	Oct. 23	45	47	32
June 22	57.5	50	50	Aug. 23	54	53.5	44	Oct. 24	44.5	47.5	35
June 23	56.5	50	50	Aug. 24	54	53.5	41	Oct. 25	44	47	35
June 24	58	51	44	Aug. 25	53	54	41	Oct. 26	43	47	26
June 25	58	51	44	Aug. 26	52.5	54	41	Oct. 27	43	47	31
June 26	57	51	47	Aug. 27	53	52.5	35	Oct. 28	45	47	32
June 27	56.5	51.5	41	Aug. 28	52	52.5	39	Oct. 29	44	47	33
June 28	57.5	51.5	46.5	Aug. 29	52	52.5	37	Oct. 30	42	45	31
June 29	56.5	51.5	40	Aug. 30	53	52.5	48	Oct. 31	42	46	32
June 30	56	52	47	Aug. 31	54	52.5	48				
July 1	56	52	48	Sept. 1	53	52.5	45				

Soil temperatures—Continued.

KENAI EXPERIMENT STATION.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1902.	°*F.*	°*F.*	°*F.*	1902.	°*F.*	°*F.*	°*F.*	1902.	°*F.*	°*F.*	°*F.*
May 19	38	....	....	June 23	54	43	....	July 28	60.5	51.5	....
May 20	37.5	....	....	June 24	55	43.5	....	July 29	60	51.5	....
May 21	38	....	....	June 25	56	44	....	July 30	57.5	51.5	....
May 22	39	....	....	June 26	56	44.5	....	July 31	57	51.5	....
May 23	39.5	....	....	June 27	55	45	....	Aug. 1	58.5	51.5	....
May 24	40.5	....	....	June 28	53.5	45	....	Aug. 2	58	51.5	....
May 25	40.5	....	....	June 29	54.5	45	....	Aug. 3	58	51.5	....
May 26	40	....	....	June 30	56	45	....	Aug. 4	56	51.5	....
May 27	41	....	....	July 1	55	45.5	....	Aug. 5	55.5	51.5	....
May 28	41	....	....	July 2	55	46	....	Aug. 6	55.5	51	....
May 29	44	....	....	July 3	56	46	....	Aug. 7	56	51	....
May 30	42	....	....	July 4	55	46	....	Aug. 8	54.5	51	....
May 31	42.5	....	....	July 5	56	46.5	....	Aug. 9	55	51	....
June 1	44.5	....	....	July 6	53.5	46.5	....	Aug. 10	56	50.5	....
June 2	46	34	....	July 7	55	47	....	Aug. 11	55	50.5	....
June 3	48	34.5	....	July 8	56.5	47	....	Aug. 12	54.5	50.5	....
June 4	49	35.5	....	July 9	57	47	....	Aug. 13	55	50.5	....
June 5	49.5	36.5	....	July 10	58	47.5	....	Aug. 14	57	50.5	....
June 6	49.5	37.5	....	July 11	56	47.5	....	Aug. 15	55	50.5	....
June 7	50	38	....	July 12	58.5	48.5	....	Aug. 16	54.5	50.5	....
June 8	50.5	38.5	....	July 13	61	49	....	Aug. 17	54	50.5	....
June 9	50.5	39	....	July 14	60.5	49.5	....	Aug. 18	52.5	50.5	....
June 10	50	39.5	....	July 15	57.5	50	....	Aug. 19	55	50	....
June 11	49.5	39.5	....	July 16	59	50	....	Aug. 20	54.5	50	....
June 12	49.5	40	....	July 17	56.5	50	....	Aug. 21	55.5	50	....
June 13	51	40	....	July 18	58	50	....	Aug. 22	55.5	50	....
June 14	52.5	40	....	July 19	58	50	....	Aug. 23	53.5	50	....
June 15	53.5	41	....	July 20	57.5	50	....	Aug. 24	53	50	....
June 16	54.5	41.5	....	July 21	58.5	50	....	Aug. 25	53	50	....
June 17	55	42	....	July 22	57.5	50	....	Aug. 26	53.5	50	....
June 18	54.5	42.5	....	July 23	57	50.5	....	Aug. 27	52.5	49.5	....
June 19	52	42.5	....	July 24	59.5	50.5	....	Aug. 28	52	49.5	....
June 20	52	43	....	July 25	60.5	50.5	....	Aug. 29	51.5	49.5	....
June 21	53.5	43	....	July 26	61	51	....	Aug. 30	54	49.5	....
June 22	55	43	....	July 27	60	51	....	Aug. 31	55	49.5	....

COPPER RIVER STATION, COPPER CENTER.

1902.	°*F.*	°*F.*	°*F.*	1902.	°*F.*	°*F.*	*F.*	1902.	°*F.*	°*F.*	°*F.*
July 26	53.5	47.5	40	Aug. 18	50	47.5	34	Sept. 10	46.5	45	43
July 27	54	48	32	Aug. 19	49	47.5	40	Sept. 11	45.5	45	44
July 28	56	48	35	Aug. 20	50	47	44	Sept. 12	44	44.5	31
July 29	58	48.5	50	Aug. 21	49.5	47	34	Sept. 13	44.5	44	41
July 30	55	48.5	32	Aug. 22	49	47	25	Sept. 14	44.5	44.5	33
July 31	55.5	48.5	49	Aug. 23	52	47	43	Sept. 15	42	44	11
Aug. 1	53.5	48.5	31	Aug. 24	50	47	31	Sept. 16	42	44	16
Aug. 2	56.5	48.5	50	Aug. 25	51.5	47	43.5	Sept. 17	41	43.5	20
Aug. 3	55	49	33	Aug. 26	48	47	32	Sept. 18	40	43.5	17
Aug. 4	53.5	48.5	34	Aug. 27	47.5	46.5	27	Sept. 19	42.5	43	29
Aug. 5	54.5	48.5	45	Aug. 28	48.5	46.5	44	Sept. 20	43	43	40
Aug. 6	53.5	48.5	43	Aug. 29	48.5	46.5	38	Sept. 21	41.5	42.5	32
Aug. 7	53.5	48.5	43	Aug. 30	48	46.5	33	Sept. 22	40	42.5	21
Aug. 8	52	48.5	24	Aug. 31	47	46.5	26	Sept. 23	40	42.5	12
Aug. 9	52.5	48	45	Sept. 1	47	46	29	Sept. 24	39	42	22
Aug. 10	53	48	45	Sept. 2	47.5	46	29	Sept. 25	37	41.5	23
Aug. 11	54	48	46	Sept. 3	47.5	46	36	Sept. 26	35.5	41	23
Aug. 12	53	48	44	Sept. 4	49	46	44	Sept. 27	34	40.5	23
Aug. 13	51.5	48	41	Sept. 5	46.5	46	28	Sept. 28	36	40.5	38
Aug. 14	51.5	47.5	50	Sept. 6	47	46	39	Sept. 29	39	40	43
Aug. 15	50.5	47.5	45	Sept. 7	47	45.5	37	Sept. 30	40	40.5	39
Aug. 16	51	47.5	46	Sept. 8	46	45.5	37				
Aug. 17	52	47.5	47	Sept. 9	45.5	45.5	39				

Soil temperatures—Continued.

EAGLE.

Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.	Day.	6-inch thermometer.	24-inch thermometer.	Radiation thermometer.
1901.	°F.	°F.	°F.	1901.	°F.	°F.	°F.	1901.	°F.	°F.	°F.
Aug. 1	48	45.5	41	Aug. 22	46	43	43.5	Sept. 12	43.5	44.5	30
Aug. 2	48.5	45	31.4	Aug. 23	46	43	31	Sept. 13	43.5	44	30
Aug. 3	50.5	45	45	Aug. 24	49.5	43	41.5	Sept. 14	41.5	44	28
Aug. 4	52	45.5	49.4	Aug. 25	50	43.5	40	Sept. 15	43.5	43.5	26
Aug. 5	49.5	45.5	31.3	Aug. 26	49.5	45	41	Sept. 16	41.5	43	21.6
Aug. 6	49.5	45.5	36.2	Aug. 27	48.5	45.5	35	Sept. 17	40.5	43	22
Aug. 7	49.5	45.5	33.5	Aug. 28	47.5	45.5	36	Sept. 18	39.5	42.5	19.5
Aug. 8	51.5	45.5	46.8	Aug. 29	49.5	45.5	46	Sept. 19	40	42	31.5
Aug. 9	50.5	45.5	47	Aug. 30	47.5	46	33.5	Sept. 20	41	41.5	33
Aug. 10	47.5	45.5	28.5	Aug. 31	45.5	45.5	26.8	Sept. 21	43	41.5	41
Aug. 11	47.5	45.5	29.8	Sept. 1	44.5	45	24.2	Sept. 22	41.5	41.5	31
Aug. 12	47.5	45.5	34.6	Sept. 2	44.5	45	32.1	Sept. 23	41.5	41.5	32
Aug. 13	47	45.5	26	Sept. 3	44.5	45	36.8	Sept. 24	40.5	41.5	27
Aug. 14	48	45	39.7	Sept. 4	43.5	44.5	24.5	Sept. 25	41	41.5	36
Aug. 15	48	45	42	Sept. 5	46	44	39	Sept. 26	40	41.5	26.5
Aug. 16	46	45	29.5	Sept. 6	45.5	44	35	Sept. 27	39	41.5	26.5
Aug. 17	47	45	40.5	Sept. 7	45.5	44	35	Sept. 28	39.5	41	30.8
Aug. 18	45.5	45	29	Sept. 8	43.5	44.5	23.9	Sept. 29	38.5	40.5	27
Aug. 19	44.5	45	25	Sept. 9	45	44	36.1	Sept. 30	37	40.5	20
Aug. 20	41.5	44	24	Sept. 10	45.5	44	39.2				
Aug. 21	41.5	43.5	19	Sept. 11	46	44.5	37.5				

WEATHER SERVICE.

In addition to the foregoing, I have also, as in the past, had charge of the volunteer weather service in Alaska. The service consists entirely of volunteer observers, who are supplied with instruments and blanks by the Weather Bureau, and who render monthly reports of their observations. The supplies are sent to the headquarters station at Sitka and from there distributed to the observers as required. The reports are likewise sent to the headquarters station, where one copy is filed and another sent to the Chief of the Weather Bureau at Washington.

Until we shall have gathered data for a series of years from all parts of Alaska in regard to rainfall, temperature, and other weather conditions, this service is of the utmost importance to the success of the agricultural investigations. Condensed data for each month from 1899 to the present are submitted herewith.

Meteorological observations.

SITKA. F. E. Rader, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	°F.	°F.	°F.	Inches.				
May	61	29	43	4.01	3	7	21	17
June	62	33	48.3	4.99	....	9	21	16
July	87	42	56.5	2.27	6	10	15	8
August	67	40	54.5	8.35	4	7	20	14
September	68	40	51.1	8.52	4	3	23	19
October	62	30	46.3	7.90	3	5	22	17
November	57	29	43.5	7.02	2	3	25	14
December	50	21	35.4	6.94	7	4	20	11

Meteorological observations—Continued.

SITKA. F. E. Rader, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°F.	°F.	°F.	Inches.				
January	48	26	36.9	8.71	3	5	23	13
February	47	10	33	3.49	9	2	17	13
March	65	−1	37.8	2.62	9	8	14	9
April	59	30	41	12.09	5	17	8	22
May	69	31	45.4	4.56	6	21	4	19
June	71	34	51.8	3.13	9	14	7	13
July	69	45	55.4	3.77	2	16	13	16
August	67	40	55.2	7.92	2	22	7	19
September	65	32	50.9	7.82	4	16	10	14
October	58	28	42.5	10.73	3	19	9	20
November	57	15	36.4	9.39	8	7	15	14
December	52	24	37.4	6.59	....	9	22	24
1901.								
January	48	18	34	9.33	7	3	21	23
February	45	13	30.3	6.38	12	6	10	9
March	46	17	36.8	7.80	4	12	15	25
April	58	27	44.5	7.17	6	12	12	15
May	65	31	44.5	4.86	8	13	10	16
June	61	36	48.6	1.26	2	11	17	9
July	74	35	54.8	.45	8	14	9	6
August	63	39	53.7	10.03	....	5	26	25
September	65	39	51.4	8.52	3	12	15	16
October	61	26	44.98	15.49	2	15	14	26
November	52	26	37.9	6.16	6	8	16	16
December	51	19	37.3	10.18	6	3	22	25
1902.								
January	49	16	36.2	10.92	4	1	26	22
February	51	26	39.5	2.25	8	7	13	10
March	50	7	34	19	6	3	22	19
April	59	28	40.7	12	3	11	16	12
May	64	34	45.7	14	8	8	15	14
June	77	36	53.9	6	11	8	11	6
July	74	38	55.53	7.35	4	11	16	20
August	64	40	54.16	14.96	....	14	17	28
September	62	40	50.3	13.43	1	11	18	26

KILLISNOO. Jos. Zuboff, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
January	40	11	29.4	6.41	6	3	22	20
February	42	3	26.5	4.80	3	....	25	20
March	44	8	28.6	2	12	6	13	7
April	47	27	38.6	1.60	5	3	22	8
May	54	26	40.6	1.40	8	3	20	6
June	65	37	48.7	3.20	1	9	20	10
July	71	44	56.5	.90	10	11	10	4
August	68	40	53.9	1.95	4	5	21	13
September	59	35	46.8	7.40	4	4	22	19
October	52	26	38.5	5.95	4	4	23	22
November	49	25	37.8	6.30	1	3	26	24
December	40	16	29.2	3.45	6	9	16	15
1900.								
January	42	11	31	5.55	3	6	22	17
February	42	10	29.9	3.35	9	4	15	12
March	50	−2	32.4	2.40	13	3	15	12
April	53	27	40.8	6.85	4	5	21	21
May	60	40	46.2	2.20	7	8	16	10
June	71	33	50.1	4.30	8	6	16	11
July	74	46	57.8	8.45	4	12	15	12
August	70	36	54.2	2.30	1	10	20	16
September	60	35	48	4.25	5	7	18	18
October	54	28	39.5	6	2	5	24	23
November	45	10	31.8	7.05	11	2	17	15
December	45	20	34.1	6.50	....	5	26	19
1901.								
January	37	13	27	6.95	6	4	21	20
February	41	9	23.2	6.05	11	5	12	11
March	43	12	34.6	5.40	2	6	23	17
April	45	23	36	1.15	2	10	18	7
May	61	31	42.8	4	4	10	17	15
June	65	34	51.3	1.60	4	14	12	5

Meteorological observations—Continued.

KILLISNOO. Jos. Zuboff, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.	°*F.*	°*F.*	°*F.*	*Inches.*				
July	71	43	57.6	1.40	6	14	11	8
August	66	40	51.5	5.95	....	9	22	20
September	63	36	49.9	5.50	....	9	21	17
October	54	32	43.6	9.10	2	23	6	22
November	42	23	34.9	3.55	0	4	26	12
December	41	21	33.5	5.30	1	7	23	17
1902.								
January	43	13	32.5	6.95	1	5	25	18
February	45	19	32.6	2.65	4	7	17	12
March	45	6	29.6	1.50	5	10	16	12
April	52	26	40.5	2.10	4	12	14	8
May	56	32	44.3	3.70	3	13	15	11
June	71	36	55.5	1.60	7	10	13	9
July	72	45	55.9	3.80	4	11	16	11
August	68	41	54	4.80	0	5	26	20
September	60	38	49.1	7.20	0	6	24	21

JUNEAU. John McLaughlin, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
January	44	4	27.4	4.22	11	15	5	17
February	42	4	26	3.81	15	18	....	13
March	44	10	29.2	1.58	9	9	13	10
April	52	30	40	4.28	6	3	21	19
May	69	29	45	4.68	4	23	4	15
June	68	40	52	5.63	4	8	18	20
July	86	48	62	1.06	18	8	5	7
August	71	42	56	4.88	6	11	14	16
September	66	36	50.3	9.10	5	3	22	23
October	58	26	40.4	11.90	10	6	15	18
November	56	28	40.6	6.71	7	7	16	18
December	48	11	31.4	8.32	13	12	6	16
1900.								
January	40	12	30.6	8.52	11	11	9	20
February	40	10	29	4.09	13	8	7	9
March	61	5	33.8	3.06	20	7	4	12
April	61	30	41.3	11.37	6	4	20	23
May	64	36	47.2	5	9	10	12	18
June	76	36	53.9	2.27	14	6	10	9
July	77	45	56.2	5.19	7	11	13	12
August	71	39	54.8	6.57	9	4	18	18
September	65	34	50.4	10.84	12	4	14	16
October	55	28	41.5	10.91	10	2	19	20
November	49	10	32.9	12.45	12	6	12	13
December	49	9	32	7.87	3	7	21	25
1901.								
January	40	10	28	9.57	8	3	20	21
February	44	13	26	6.32	16	2	10	8
March	48	16	36	8.23	10	4	17	17
April	55	28	40	8.39	14	3	13	13
May	67	33	46	3.57	10	9	12	17
June	69	39	53.3	1.93	8	10	12	11
July	79	40	57	1.98	15	4	12	12
August	67	45	53.7	14.04	2	2	27	22
September	65	36	49.5	11.41	7	6	17	18
October	57	23	44.2	16.50	5	8	18	26
November	44	20	34.2	35.2	5	20	5	17
December	46	13	34.5	13.33	8	3	20	23
1902.								
January	43	12	33	11.96	7	1	23	23
February	50	21	35.8	2.08	8	7	13	19
March	50	3	30.4	5.64	7	9	15	18
April	61	30	41.3	4.34	9	7	14	13
May	65	35	48.3	3.99	14	14	3	12
June	80	42	67.3	2.41	9	12	9	11
July	72	43	54.8	7.60	5	5	21	13
August	62	41	52.4	12.10	1	6	24	25
September	59	37	49.1	14.24	1	8	21	25

Meteorological observations—Continued.

KETCHIKAN. D. S. Whitfield, Observer.

Month.	Temperature. Maximum.	Temperature. Minimum.	Temperature. Daily mean.	Total precipitation.	Weather conditions (number of days). Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	°F.	°F.	°F.	Inches.				
May (9 days)	57	44	48.9	6	5	2	2	6
June	78	46	57.5	3.37	28	1	1	14
July	69	62	58.6	5.62	25	3	3	9

SKAGWAY. George Sexton, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
January	40	−2	22.2	0.94	18	4	9	8
February	44	−9	19.2	.88	17	3	8	3
March	47	1	23.4	.13	22	3	6	2
April	61	16	41.4	.66	11	18	1	8
May	77.5	25	47.1	1.07	14	11	6	7
June	80	34	54	1.29	10	11	9	11
July	92	41	61.4	.59	19	7	5	3
August[a]	...	...	...	...	...	...	...	...
September	76	30	50	4.68	5	9	16	17
October	53	16	35.7	3.05	10	15	6	10
November	49	24	35.7	2.62	9	6	15	10
December	45	−1	23.5	1.44	16	4	11	9

SKAGWAY. J. T. Hayne, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.								
January	42	0	17.9	0.86	10	13	8	7
February	41	−3	23.6	.16	24	2	2	1
March	63	10	29.4	1	24	4	3	2
April	58	21	40.4	4.12	10	10	13	13
May	65	30	49	.12	23	6	2	3
June	93	37	58.6	.20	21	8	1	1
July	84	40	59.6	1.70	20	6	5	4
August	75	38	57.9	0	15	15	1	0
1901.								
October	60	27	41.7	4.92	5	3	23	16
1902.								
May	79	30	35	.13	16	...	15	4
June	86	37	59	.30	16	4	10	3
July	76	39	57	10	6	8	17	10
August	68	32	54	3.03	2	19	10	17
September	62	35	50	1.74	4	17	9	10

ORCA. Capt. O. J. Humphrey, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
June	77	35	51.1	...	19	1	10	9
July	86	46	61	...	15	2	14	14
August	78	41	57.1	...	11	11	7	9
September	74	31	49.2	13.90	...	...	...	...
October	59	26	38.8	17.87	12	1	18	14
November	48	28	34.4	13.02	4	5	21	16
December	47	10	28.2	9.95	12	3	16	13
1900.								
January	43	10	27.4	9.78	9	0	22	16
February	41	15	30.4	9.93	13	1	14	11
March	57	10	35.9	15.74	16	3	12	10
April	64	25	39.6	16.35	6	2	22	22
May	64	28	43.7	13.70	3	8	20	20
June	...	...	...	4.59	13	4	13	11
July	...	...	...	5.06	9	9	12	13
August	...	...	...	11.25	6	8	17	19
September	...	...	...	15.32	11	1	18	14
October (25 days)	53	25	37.8	7.68	10	3	16	17
November	47	14	28.9	4.75	16	3	11	7
December	47	7	29	13.9	10	3	18	15

[a] No report received.

Meteorological observations—Continued.

ORCA. Capt. O. J. Humphrey, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.	°*F.*	°*F.*	°*F.*	*Inches.*				
January	40	9	27.1	16.17	13	1	17	16
February	38	8	25	1.21	13	2	13	5
March	50	11	34	16.91	6	2	23	22
April[a]	......	......	......	......	......	......	......	......
May[a]	......	......	......	......	......	......	......	......
June[a]	......	......	......	......	......	......	......	......
July	79	33	53	3.86	11	8	12	9
August	71	41	52.7	27	3	......	28	22
September	74	35	49.6	26.3	10	......	20	19

ORCA. W. J. Shepard, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.								
October	51	28	41	24.01	3	1	27	26
November	46	21	33	8.02	4	10	16	16
December	47	9	29	9.35	5	26	......	13
1902.								
January	49	5	17	23	3	21	7	16
February	42	25	34.9	5.65	4	11	14	11
March	45	6	29.6	29.6	26	4	1	......

FORT LISCUM (VALDEZ). James B. Jackson, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.								
November	50	0	22.4	2.85	......	......	......	6
December	39	−8	21.6	4.82	......	......	......	9
1901.								
January	41	−1	23.8	9.4	10	7	14	13
February	41	−12	15.5	.80	16	8	4	3
March	52	10	30.8	6.38	8	8	15	18
April	50	19	31.6	6.20	13	4	13	12
May	57	27	39.4	1.45	23	1	7	4
June	67	32	49.6	1.13	18	......	12	10
July	73	32	50.5	4.77	22	......	9	9
August	63	30	46.6	16.21	2	1	28	28

FORT LISCUM (VALDEZ). James T. Arivine, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.								
September	64	25	43.92	12.72	9	0	21	19
October	53	18	42.3	10.31	8	0	23	21
November	45	4	15.33	6.10	13	0	17	12
December	39	−13	15.98	7.03	9	0	22	17
1902.								
January	44	−14	13.52	9.64	6	0	25	22
February	42	6	16.83	1 28	18	0	10	7

FORT LISCUM (VALDEZ). C. J. Bartlett, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.								
March	44	8	19.48	4.90	17	0	14	11
April	52	2	25.9	2.08	23	0	7	6
May	62	25	19.42	3.08	17	0	14	14
June	79	36	15.93	6	15	0	15	6
July	77	32	22.96	20	8	0	23	20
August	70	33	52	29	6	......	25	29
September	58	27	......	26	8	1	21	26

[a] No report received.

Meteorological observations—Continued.

KENAI. H. P. Neilsen, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	°F.	°F.	°F.	Inches.				
May	60	22	41	8.20	8	10	13	9
June	68	31	47.9	6.80	13	8	8	7
July	82	31	54.1	1.36	12	8	10	9
August	66	28	51.9	2.34	10	12	9	15
September	73	17	46.3	4.15	7	9	14	13
October	51	10	34.7	4.32	6	6	19	12
November	44	3	27.2	.32	6	6	18	4
December	41	−14	13	.67	14	7	10	6
1900.								
January	38	−26	7.8	1.47	15	8	8	7
February	44	−10	22.9	.31	10	4	14	4
March	52	− 8	30	.32	15	8	8	3
April	58	10	35.2	.52	8	8	14	11
May	60	21	42.7	.37	7	7	17	6
June	77	30	48.8	.55	5	0	25	4
July	72	33	54.9	.86	6	13	12	5
August	66	29	51.8	3.92	8	7	16	16
September	65	21	46.30	3.34	15	4	11	12
October	54	− 5	32.24	2.19	6	10	15	8
November	34	−26	13.3	.90	14	5	11	6
December	42	−32	14.9	1.15	11	3	15	7
1901.								
January	45	−36	11.7	.64	15	3	12	6
February	37	−28	14.2	.07	13	8	7	1
March	50	−21	28.4	.32	6	12	11	7
April	51	10	32.9	.85	14	4	12	6
May	63	23	42.1	.30	18	7	6	2
June	69	29	50.8	.06	13	6	11	0
July	80	30	52.7	1.76	12	4	15	11
August	73	31	52.5	4.75	3	12	16	16
September	62	19	46.5	2.27	13	4	13	14

KENAI. Geo. S. Mearns, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.								
October	60	−10	38.67	1.69	2	12	17	9
November	42	− 4	19.86	.33	6	13	11	6
December	45	−17	18.41	.19	13	6	12	4
1902.								
January	40	−36	14.93	.80	11	13	7	6
February	45	−15	16.21	.44	6	12	10	4
March	43	−34	26.54	.50	12	9	10	4

KENAI. H. P. Neilsen, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.								
April	47	4	30.36	1.03	6	15	9	4
May	62	23	42.06	8	14	7	9	8
June	79	29	53.73	.59	20	7	3	3
July	75	35	55.5	1.71	12	8	11	10
August	70	35	53.8	2.92	4	5	22	19

TYONEK. Thomas W. Hanmore, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
January	34	− 8	5.41	1	19	7	5	6
February	38	−12	15.3	.85	17	....	11	6
March	48	− 4	23.6	.65	22	....	9	2
April	52	22	37.7	1.43	19	5	6	3
May	60	30	43.1	1.05	13	10	8	5
June	68	34	53.1	1.20	24	1	5	4
July	82	45	58.7	....	18	3	10	9
August	71	38	56.4	2.72	10	8	13	17
September	70	29	49	5.51	9	11	10	14
October	52	18	35.4	4.02	9	11	11	12
November	44	7	29.2	.58	10	10	10	3
December	41	0	17	.73	20	4	7	3

Meteorological observations—Continued.

TYONEK. Thomas W. Hanmore, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°F.	°F.	°F.	Inches.				
January	35	0	13.4	2.69	15	4	12	6
February	39	1	23.7	.52	14	4	10	6
March	58	1	31.9	.59	17	5	9	5
April	56	11	35.5	.60	9	10	11	6
May	68	33	45.4	.29	12	8	11	5
June	82	40	52.9	.72	23	0	7	6
July	75	40	57	1.05	18	7	6	5
August	73	31	54.6	4.94	10	5	16	17
September	67	32	48.7	4.22	14	7	9	11
October	61	10	36.3	1.87	16	3	12	8
November	34	−6	16.6	.60	18	4	8	3
December	42	17	13.9	1.54	15	2	14	7
1901.								
January	38	−19	14.9	1.55	18	3	10	9
February	36	−17	29.3	.20	16	2	10	5
March	46	−3	33.5	.62	12	5	14	6
April	56	12	33.5	1	19	3	8	5
May	67	22	45.3	.04	25	4	1	1
June	74	33	53.8	.53	15	9	6	7
July	83	38	59	2.68	18	5	8	8
August	62	37	51.7	5.77	5	9	17	17
September	68	32	47.9	3.16	12	5	13	16
October	61	10	16.2	1.87	16	3	12	8
November	41	2	11.9	.45	10	9	11	7
December	49	−17	15.9	1.13	16	4	11	8
1902.								
January	38	−27	12.41	3.08	10	3	18	9
February	49	3	15.71	.52	7	2	19	3
March	53	−9	23.12	1.09	14	7	10	5
April	59	1	31	2	14	6	10	2
May	65	29	11.2	3	17	7	7	3
June	80	39	22.5	0	24	6	....	....
July	82	42	19.7	2.85	16	6	9	11
August	73	13	13.9	2	3	7	21	20
KADIAK. William J. Fisher, Observer.								
1899.								
January	51	−1	25.3	4.72	10	2	9	16
February	52	5	33.5	4.44	7	3	18	14
March	64	11	36	4.17	18	4	9	11
April	61	23	35.9	3.02	15	2	13	14
May	62	24	44.5	4.97	15	5	11	14
June	76	34	54	2.11	20	2	8	9
July	82	41	59.4	.82	19	3	9	7
August	75	41	58.2	2.37	20	3	8	10
September [a]	....	....	....	....	....	....	....	....
October	59	31	43.3	6.31	13	2	16	19
November	53	23	38.4	5.57	7	0	23	19
December [a]	....	....	....	....	....	....	....	....
KADIAK AND WOOD ISLAND. Curtis P. Coe, Observer.								
1900.								
January (27 days)	49	0	28.25	2.95	7	2	18	10
February	49	20	35.4	6.19	9	0	19	19
March	51	18	37.92	7.46	9	5	17	18
April	54	11	37.8	2.60	12	5	12	12
May	64	30	44.8	6.62	7	8	16	16
June	71	39	51.6	3.35	12	2	16	9
July	68	45	54.94	6.64	8	5	18	12
August	70	42	56.6	2.74	9	8	14	17
September	68	36	50.4	1.95	....	....	....	12
October (25 days)	63	22	41.9	1.85	4	4	18	9

[a] No report received.

Meteorological observations—Continued.

WOOD ISLAND. Curtis P. Coe, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°F.	°F.	°F.	Inches.				
October	63	22	42.2	1.86	4	4	18	9
November	54	9	31.9	2.28	14	2	14	5
December	49	12	31.7	4.73	11	5	15	9
1901.								
January	47	7	30	2.65	11	6	14	9
February	58	4	30.6	.30	15	10	3	3
March	54	5	34.8	3.85	5	8	18	18
April (16 days)	55	17	36.4	4.20	10	3	3	8
May	63	20	43.2	3.45	15	3	13	16
June	73	37	51.2	4.50	15	3	12	11
July	79	42	55.3	3.56	14	3	14	8
August	70	43	54.6	5.13	4	5	22	19
September	70	36	51.27	10	7	5	17	10
October	66	25	44.1	8.95	4	3	24	21
November	52	14	35.07	4.82	8	4	18	0
December	47	2	33.82	11.10	3	4	24	20

COAL HARBOR, UNGA ISLAND. H. S. Tibbey, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
January	45	− 6	26.3	3.30	10	6	15	13
February	45	0	31.9	3.77	8	3	17	14
March	48	5	34.6	4.04	10	14	7	12
April	50	25	35.8	1.82	5	3	22	14
May	54	20	39.5	3.72	5	4	22	14
June	65	15	40	.39	18	1	11	4
July	79	40	54.9	6.21	12	5	14	12
August	69	42	54	4.87	5	4	22	10
September	66	32	48.7	4.99	5	3	22	11
October	58	31	43.6	5.04	7	2	22	18
November	49	21	36	1.91	10	0	20	6
December	46	5	27.9	.70	5	4	22	4
1900.								
January	46	0	28.1	2.69	5	2	24	8
February	51	17	35	4.33	3	0	25	16
March	53	10	33.4	2.09	11	3	17	8
April	47	10	32.3	15.53	1	9	20	19
May	57	24	40.7	2.16	2	14	15	8
June	69	36	49.5	1.88	1	6	23	6
July	69	40	51.6	2.91	5	7	19	17
August	69	42	54.2	5.47	0	4	27	16
September	64	34	49.4	4.65	3	7	20	13
October	60	25	43	5.35	....	4	27	24
November	56	18	36	7.98	4	5	21	19
December	47	13	31	3.20	8	3	20	18
1901.								
January	47	11	31	4.15	9	5	17	14
February	49	− 2	29	6.36	7	3	18	16
March	48	7	27.6	1.98	3	6	22	16
April	50	12	31.8	3.54	2	7	21	19
May	57	22	38.7	.66	8	8	15	9
June	61	29	45.3	2.21	10	4	16	14
July	69	38	51.9	1.64	8	8	15	8
August	68	38	52.2	1.63	2	5	24	18
September	64	35	47.9	13	6	3	22	13
October	54	26	40.8	7.45	5	9	17	16
November	48	16	32.9	3.53	5	8	17	23
December	50	8	32.1	8.87	5	2	24	21
1902.								
January	46	− 2	31.2	6.53	6	2	23	20
February	48	17	33.8	4.24	7	8	13	16
March	48	12	31.8	5.34	7	9	15	2
April	59	4	33	4.76	9	3	18	16
May	58	32	42.4	2.98	9	5	17	12
June	71	37	52.6	.33	18	4	8	4
July	78	54	55.9	1.70	11	5	15	12
August	67	42	52.5	3.05	3	5	5	23	18

Meteorological observations—Continued.

NUSHAGAK, BRISTOL BAY. S. H. Rock, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.	°*F.*	°*F.*	°*F.*	*Inches.*				
January	42	−41	14	1.4	7	6	18	8
February (19 days)	60	5	16.45	3	5	9	5	3
March	62	−70	11	2.45	10	10	11	8
April	47	−15	23.5	8	13	4	13	8
May	65	23	22	10	8	5	18	10
June	81	35	32.08	2	19	8	3	2
July	78	38	48.90	3	6	9	16	14

ST. MICHAEL. Rev. J. Post, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
October	42	13	32.2	0.4	3	13	15	2
November	31	1	17.4	.80	4	8	18	5
December	35	−36	4.4	0	7	7	17	0
1900.								
January	30	−38	− 6.1	.40	18	4	9	2
February	38	−13	16	1	13	5	10	1
March	40	−18	10.4	1	15	3	13	1
April	44	−26	17.6	.40	9	2	19	2
May	54	17	34.7	0	8	6	17	0
June	64	31	44.2	0	10	3	17	0
July	77	40	55.6	(a)	5	5	21	....
August	65	37	50.2	(a)	2	2	27	....
September	56	25	43.6	(a)	....	....	30	....
October	53	0	30.4	(a)	3	2	26	....
November	43	− 9	21	(a)	9	2	19	....
December	33	−12	11	(a)	8	3	20	....
1901.								
January	37	−30	− 5.4	(a)	18	1	12	....
February	38	−27	7	(a)	15	1	12	....
March	24	−16	3.5	(a)	15	2	14	....
April	37	−15	11.8	(a)	15	3	12	....
May	43	− 3	25.2	(a)	13	1	17	....
June	61	23	40.8	(a)	3	1	26	....

NOME. N. A. T. & T. Co., Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.								
August (19 days)	59	28	45.4	0.60	9	10	0	3
September	54	22	39	7	11	4	15	17

KOTZEBUE SOUND. Anna M. Foster, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1898.								
June	72	27	48	(a)	20	(a)	10	(a)
July	81	82	55	(a)	14	(a)	17	(a)
August	64	38	50	(a)	8	(a)	23	(a)
September	50	25	39.4	(a)	12	(a)	13	(a)
October	43	− 5	24.3	(a)	18	(a)	13	(a)
November	19	−23	0	(a)	17	(a)	13	(a)
December	27	−39	7.2	(a)	13	(a)	18	(a)
1899.								
January	17	−31	−10	(a)	17	(a)	14	(a)
February	23	−38	− 9	(a)	20	(a)	8	(a)
March	32	−36	1	(a)	15	(a)	16	(a)
April	40	−24	12	(a)	16	(a)	14	(a)
May	59	− 4	29.3	(a)	13	(a)	17	(a)
June	53	27	37.4	(a)	14	(a)	16	(a)
July	67	34	49.4	(a)	13	(a)	18	(a)
August	63	18	38.6	(a)	16	(a)	15	(a)
September	63	18	38.6	(a)	16	(a)	15	(a)
October	37	− 2	22	(a)	8	(a)	23	(a)
November	22	−17	7	(a)	15	(a)	15	(a)
December	22	−35	− 9	(a)	13	(a)	18	(a)

[a] Not reported.

Meteorological observations—Continued.

KOTZEBUE SOUND. Robert Samms, Observer.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1900.	°F.	°F.	°F.	Inches.				
January	21	−43	−17.1	(a)	20	(a)	11	(a)
February	29	−25	3.3	(a)	19	(a)	9	(a)
March	39	−27	1.2	(a)	20	(a)	11	(a)
April	39	−27	7.6	(a)	17	(a)	13	(a)
May	44	2	28.7	(a)	25	(a)	6	(a)
June	65	27	39.2	(a)	16	(a)	14	(a)
July	71	35	53	(a)	23	(a)	8	(a)
August	66	31	48.8	(a)	15	....	16	....
September	52	27	39.1	(a)	6	....	24	....
October	45	−14	22.7	(a)	10	....	21	....
November	38	−20	9	(a)	15	....	15	....
December	20	−26	2	(a)	8	....	23	....
1901.								
January	33	−50	−24.8	(a)	11	....	20	....
February	34	−45	− 6.5	(a)	14	....	14	....
March	22	−27	− .5	(a)	28	....	3	1
April	35	−20	8.3	(a)	20	....	10	....
May	48	....	22.6	(a)	19	....	12	....

TELLER REINDEER STATION. T. L. Brevig, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.								
July (7 days)	57	33	44.6	1	3	1	3	1
August	51.9	41.3	47.6	2.5	6	6	19	10
September	69	26	43.06	0	7	7	16	0
October	43	4	17.83	1.5	9	4	18	10
November (23 days)	25	2	16.1	1	6	7	10	8
December	37	−22	16	3.5	10	....	21	3
1902.								
January	36	−44	....	7	9	3	19	2
February	36	−20	5.4	3	13	2	13	2
March	20	−28	−17.1	2	26	1	4	2
April	40	−29	19	4	17	2	11	5
May (26 days)	59	−20	20	(a)	9	6	10	0
June (29 days)	75	31	44.92	(a)	16	11	12	0

EAGLE. U. G. Myers, Section Director.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
August (16 days)	76	24	50.1	1.63	2	5	9	8
September	66	8	41	.80	3	7	20	7
October	41	−19	21	.65	4	9	18	7
November	33	−25	1.2	.52	2	4	24	5
December	31	−57	−19	.26	15	3	13	6
1900.								
January	23	−68	−24.8	.52	14	6	11	7
February	18	−51	− 6	.39	11	9	9	5
March	56	−46	13	.02	17	8	6	2
April	54	−12	29.3	.42	6	13	11	6
May	69	20	42.2	.84	9	17	5	7
June	87	28	52.6	1.57	8	7	15	13
July	81	31	56.9	1.88	12	9	10	13
August	79	25	49.1	2.71	2	9	20	16
September	68	15	40.4	1.72	4	6	20	14
October	44	−17	20.1	1.23	5	10	16	10
November	18	−42	−10	.21	9	8	13	5
December	32	−52	− 7.4	.77	9	6	16	8
1901.								
January	32	−68	−17.8	.42	13	8	10	8
February	28	−65	−15.3	.55	15	6	7	4
March	42	−49	5	.55	9	8	14	9
April	53	26	19	.56	8	12	10	6
May	71	16	39.1	1.63	11	8	12	9
June	34	27	52.8	1.22	3	13	14	11

(a) Not reported.

Meteorological observations—Continued.

EAGLE. U. G. Myers, Section Director—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.	°F.	°F.	°F.	Inches.				
July	85	36	57.6	1.47	9	9	13	12
August	76	31	49	1.7	2	10	19	17
September	67	31	42	.90	3	9	18	3
October	53	−22	23.6	1.06	4	7	20	7
November [a]	....	....	....	....	....	....	....	....
December	−30	−52	−7	.07	7	2	22	5

EAGLE. C. A. Trenholtz, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.								
January	25	−52	10.28	0.99	14	0	17	7
February	38	−49	5.35	0	19	2	7	0
March	42	−45	− 6.55	.17	21	1	9	24
April	58.5	− 8	26.41	.84	11	3	16	8
May	75	18	45.01	.64	7	11	13	6
June	86	26	56.08	1.15	14	11	5	6
July	82	40	60.87	2.5	7	11	13	13
August	78	31	54.50	1.28	11	11	9	10
September	63	22	40.53	.90	8	6	16	9

FORT YUKON. L. J. H. Wooden, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.								
September	54	9	34.3	0.10	....	....	....	....
October	40	−13	18.7	.45	4	15	12	6
November	23	−34	− 1.4	.30	8	12	10	3
December	16	−68	−16.1	.47	4	10	17	5
1900.								
January	....	−62	....	.36	19	5	7	7
February	....	−44	....	.00	20	8	0	0
March	....	−42	....	.42	14	10	7	5
April	....	−21	....	.05	15	9	6	3
May [a]	....	....	....	....	....	....	....	....
June	93	27	58.6	1.19	6	21	3	9
July	87	41	64.2	.32	13	15	3	3
August	80	23	53.6	1.32	5	9	16	11
September	70	19	42.6	.45	5	4	19	8
October	48	−17	16.9	.59	5	11	15	11
November	22	−43	−10.8	.51	8	13	9	6
December	8	−56	−26	.24	5	9	17	5
1901.								
January	....	−65	....	.55	12	5	13	8
February	....	−53	....	.03	15	9	4	2
March	25	−41	1.6	.38	9	17	5	8
April	51	−16	17.4	.56	16	14	....	5
May	66	8	33.2	.46	17	13	1	6
June	85	26	58.6	.41	12	18	....	4
1902.								
January	....	−69	....	....	....	....	....	....
February	....	−53	....	....	....	....	....	....
March	....	40	....	3	....	....	....	....
April	....	29	....	....	....	....	....	9
May	65	45	....	....	....	....	....	1

HOLY CROSS MISSION. Rev. R. J. Crimont, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1898.								
November	32	−23	1.9	2.48	9	10	11	13
December	30	−37	3.4	....	9	15	7	5
1899.								
January	35	−40	− 3.2	5.10	15	6	10	3
February	39	−37	− 3.1	1.46	18	5	5	0
March	45	16	15.6	1.49	14	9	8	6
April	46	0	27.3	1.42	13	9	8	9

[a] No report received.

Meteorological observations—Continued.

HOLY CROSS MISSION. Rev. R. J. Crimont, Observer—Continued.

Month.	Temperature.			Total precipitation.	Weather conditions (number of days).			
	Maximum.	Minimum.	Daily mean.		Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1899.	°*F.*	°*F.*	°*F.*	*Inches.*				
May	57	13	39.4	.30	18	12	11	
June	74	24	50.6	....	11	12	7	....
July	82	31	56.9	....	8	6	17	....
August	70	31	51.5	3.67	0	12	19	14
September	62	17	40.9	4.40	2	15	13	19
October	44	16	30.3	1.17	4	12	15	15
November	23	− 5	10.6	.49	10	18	2	8
December	34	−40	− 2.2	.82	16	7	8	9
1900.								
January	35	−55	− 9.6	.74	23	4	4	7
February	39	−15	14.7	.57	12	8	8	8
March	44	−13	15.5	.50	22	4	5	5
April	48	−21	24.7	.46	5	15	10	6
May	63	18	42.5	.92	5	18	8	11
June	74	29	52.4	1.67	16	7	7	7
July	77	41	58.8	1.44	12	10	9	15
August	64	35	52	5.74	2	10	19	29
September	57	25	44.1	6.69	3	15	12	20
October	57	−14	27.8	3.34	4	11	16	18
November	41	−19	14.4	1.98	12	6	12	7
December	35	−24	5.8	4.49	10	9	12	16
1901.								
January	30	−45	−11.4	1.46	14	4	13	9
February	41	−32	8.3	2.46	9	9	10	11
March	37	−28	10	1.06	5	20	6	10
April	46	−13	20.6	.55	14	8	8	6
May	57	8	55.2	.13	16	12	3	3
June	70	29	51.9	.85	7	13	10	10
July[a]	....	....	....	....	....	....	....	....
August	68	30	50.4	4.50	2	3	26	11
September	60	26	47	8	....	15	15	30
October	43	32	11.7	6	3	22	6	6

RAMPART. Alvin Liebes, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1901.								
September (last 6 days)	49	22	41.2	(*a*)	1	....	5	1
October (23 days)	45	−12	22.7	(*a*)	2	3	18	....
November	28	−52	− 5.8	(*a*)	....	....	....	....
December	30	−53	−11.2	(*a*)	....	....	....	....
1902.								
January	19	−61	−23.4	(*a*)	....	....	....	....
February	41	−48	−10.3	(*b*)	....	....	....	....

COPPER CENTER. J. W. Neal, Observer.

Month.	Maximum.	Minimum.	Daily mean.	Total precipitation.	Clear.	Partly cloudy.	Cloudy.	Rain or snow.
1902.								
July (14 days)	94	38	61.3	7	2	5	7	7
August	85	28	54.82	12	9	13	9	12
September	68	37	50.2	5	4	6	20	5

[a] Not reported.

[b] Rain from evening of 4th to evening of 7th.

ANNUAL REPORT OF THE HAWAII AGRICULTURAL EXPERIMENT STATION FOR 1902.

By Jared G. Smith, *Special Agent in Charge*

INTRODUCTION.

During the period from July 1, 1901, to June 30, 1902, an endeavor was made to place the Hawaii Agricultural Experiment Station on a working basis. During the short period between my arrival in Honolulu, early in April of the previous fiscal year, and the close of that year (June 30, 1901) but the barest commencement had been made. The buildings intended for laboratory, office, and residence were only partially completed, so that the first half of the fiscal year 1902 was devoted entirely to finishing the actual construction of buildings and permanent improvements. No additions to the list of structures mentioned in my annual report for 1901 were made, but much labor was utilized in grading, road making, and the preparation of land for cultivation experiments.

Considerable sums were expended in securing books and periodicals for a library. As a nucleus I have donated to the station my own private library of botanical and agricultural literature, amounting to about 2,000 books and pamphlets. These, with the books and periodicals purchased for the station and those supplied by the Department of Agriculture, make a fairly good working library, especially strong along the lines of systematic and economic botany and tropical agriculture. There is also a good series of bulletins from the State experiment stations and the United States Department of Agriculture. A considerable number of works relating to Hawaii have also been secured. A card index of literature in our library is being prepared so that the collection, while small, will be readily available to workers.

PUBLICATIONS.

A paper relating to "sore head" and other diseases of chickens in Hawaii, prepared by my assistant, T. F. Sedgwick, was published as Bulletin No. 1 of this station. About 2,000 copies have been distributed in the Territory. Sore head is a disease common to poultry, not only in Hawaii, but in many other tropical lands, as well as in Florida and California. It is a skin disease of fungus origin. Eruptions form on

the head of the fowl and spread until the ears, nostrils, and eyes are closed by a crust or scab, so that the birds become blind. The disease is fatal to young chickens, and has much to do with the high price of poultry in these islands. Preventive treatment consists in hygienic measures, cleanliness of runs and houses, good food, pure water, and destruction of lice and other parasites. These are but precautionary. When fowls become infected with sore head they may be cured by washing with warm soap and water, followed by antiseptics, such as permanganate of potash, carbolated vaseline, kerosene oil, and others. Other common diseases, such as roup, gapes, cholera, and intestinal worms, were described and remedies given.

EXPERIMENTS WITH TARO ROT.

As stated in my previous report, an experiment was undertaken to determine the nature of a disease of wet-land taro which is quite prevalent and destructive, especially on the island of Oahu, and remedial treatments for it. Taro is the staple food plant of the native Hawaiian. It is a marsh or aquatic plant which has been so long cultivated in tropical countries that, like the banana, sweet potato, and many other crops, it has apparently lost the power of propagating itself by seed. As a result of this artificial or specialized condition, and also because this crop has been grown for generations upon the same fields, without rotation of crops, fertilization of the soil, or the introduction of new strains or varieties, much of the Hawaiian taro has become constitutionally weak and subject to disease.

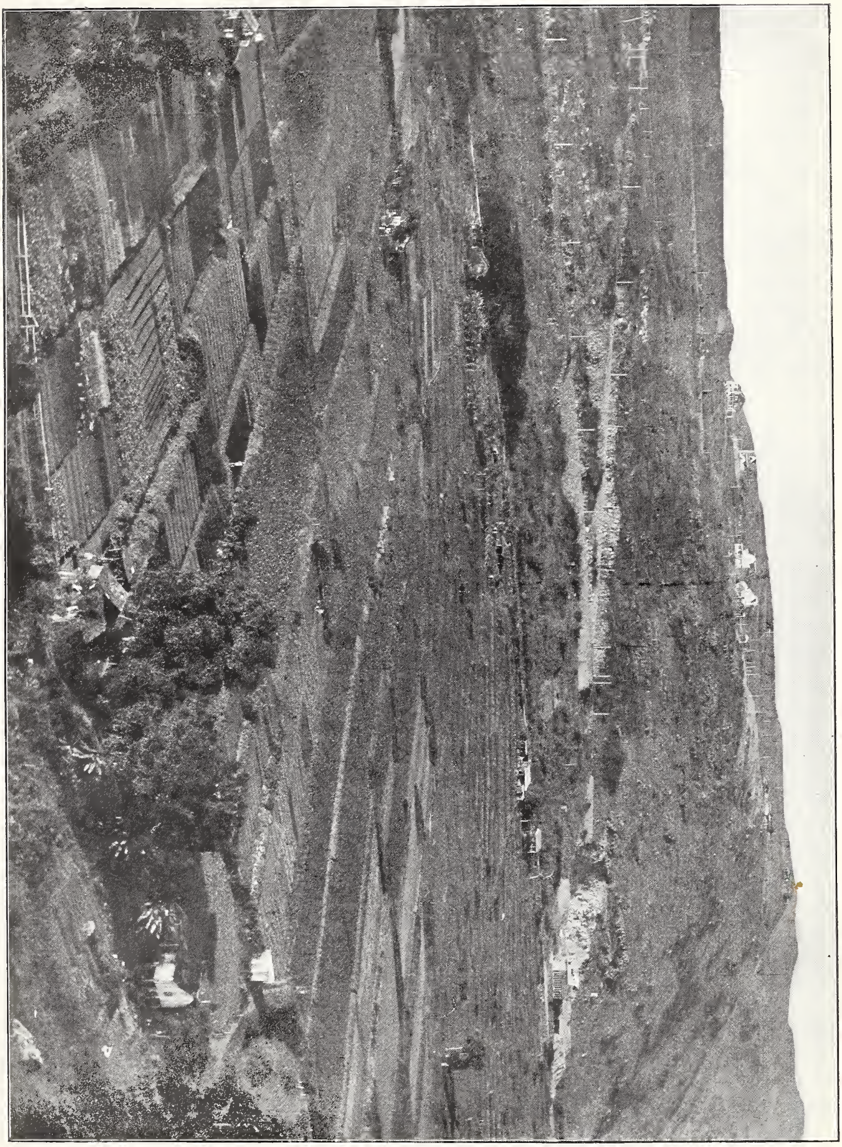
Taro is the chief food plant of the Hawaiians, and the industry in Hawaii represents an investment of fully $500,000, and the annual sales amount to more than $100,000. Furthermore, it is a crop for which no substitute has been found. All parts of the plant are eaten. The root is used as a vegetable; for making Taro-ena, a health food of much value for invalids; and poi, the national Hawaiian food. The leaves are eaten like spinach; the leafstalks like chards or asparagus, and the cooked flowers are highly esteemed as a vegetable of extremely delicate flavor. The refuse portions of the root, not used in poi manufacture, are utilized for fattening pigs.

In the vicinity of Honolulu and in many other localities on Oahu and Kauai where the lowland taro is cultivated a disease has recently become prevalent known as "root rot." In some kuhlianas, or taro patches, the root rot destroys from 50 per cent to 80 per cent of the crop. It has become so serious in some localities that the land is now devoted to the less remunerative rice cultivation. Good taro land with water rights is worth from $500 to $1,500 per acre, but if the taro root rot is prevalent the land becomes less valuable.

For the purpose of studying the nature of this disease and the methods to be adopted for its cure or prevention, a taro patch consist-

FIG. 1.—HAWAII STATION—NEW DWELLING.

FIG. 2.—HAWAII STATION—A FOREST CLEARING, SOUTH KONA.



HAWAII STATION—TARO PLANTATIONS, NEAR HONOLULU.

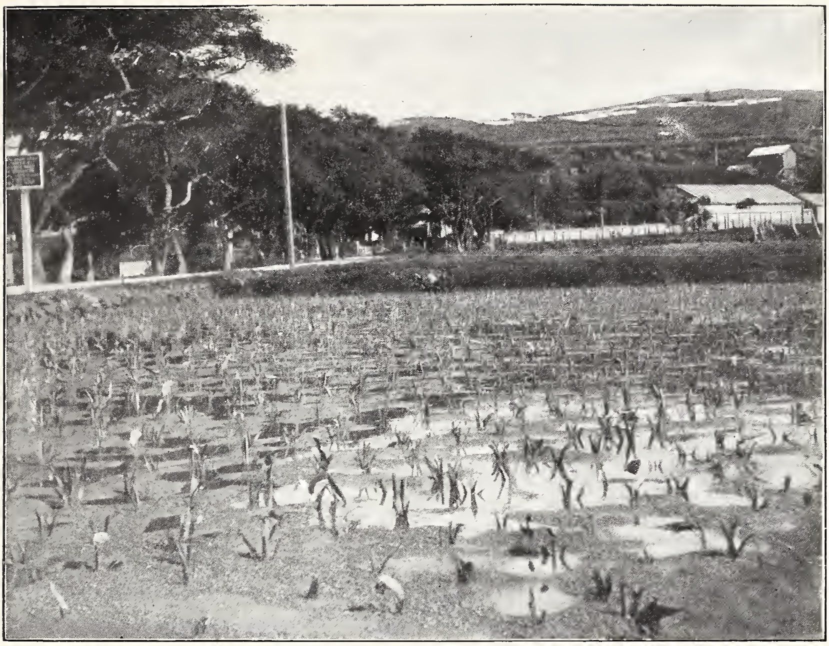


FIG. 1.—HAWAII STATION—TARO RECENTLY PLANTED.

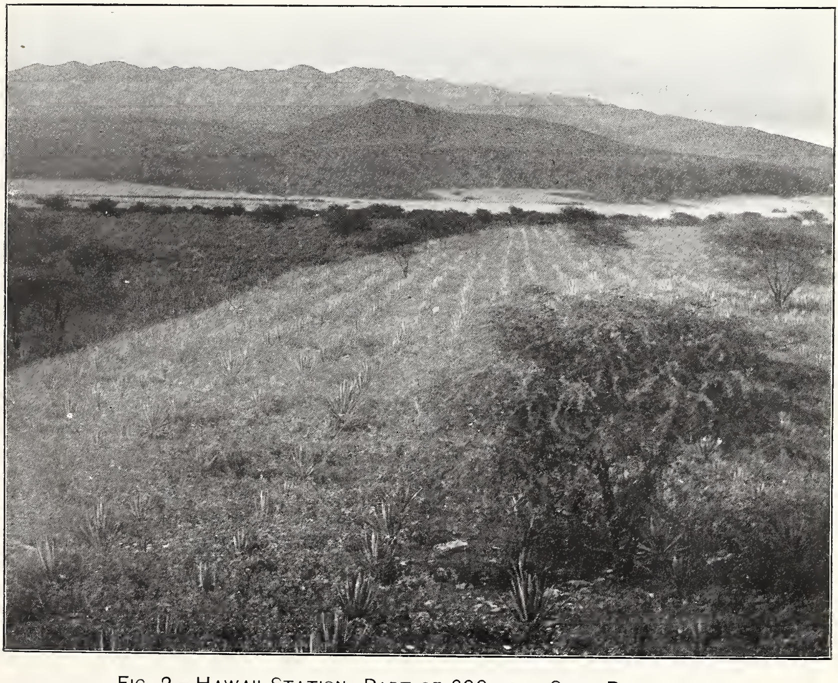


FIG. 2.—HAWAII STATION—PART OF 600-ACRE SISAL PLANTATION.

of one-ninth of an acre was secured from Judge W. L. Wilcox in one of the western suburbs of Honolulu. This field was one on which the root rot had been especially bad during the preceding season. The plat was drained, dug up, and given a heavy dressing of lime. Hules, or sets, from plants infected with root rot were planted in this field in October, 1901. When the plants were well established and commenced to grow, a fertilizer containing nitrogen, phosphoric acid, and potash was applied. Notes and observations were taken to show the progress of the experiment at weekly intervals, and examinations were made to determine the presence of the disease. An additional dressing of complete fertilizer was applied in the early part of 1902, and a dressing of nitrate of soda at the time the roots were commencing to enlarge in June. When the crop was harvested in September, 1902, the taro on this experimental plat was much larger and better than that grown on any of the adjoining lands. Although the field used was one on which there had been almost no crop during the previous season because of the disease, and furthermore, the experimental plat had been planted with diseased slips, the harvest showed a remarkable decrease in the number of rotted taro roots. Enough has been learned during this first season's work to indicate that the disease may be prevented by proper liming and fertilization of the soil on which the taro is grown, and by selecting for planting only those slips or hules which are free from the root-rot disease. A further experiment on the same land will be conducted during the coming season with a view to confirming the results of this preliminary trial.

GRAZING INVESTIGATIONS.

Some work has been done with a view to a systematic study of the forage resources of the islands. It is estimated that there are about 125,000 head of cattle on some 70 or more ranches throughout the islands, this number being exclusive of those kept solely for dairy purposes. The grazing lands constitute over three-fifths of the area of the Territory. The ranches vary from a few hundred acres to as much as 400,000 acres, and extend from sea level to the tops of the highest mountains—13,800 feet.

The grade of cattle carried on these ranges is very good. There are many pedigreed bulls and cows, representatives of all the best beef strains. Blooded stock has been imported from California and other States on the mainland, New Zealand, Australia, and Germany, and other European countries. On most of the ranches a considerable proportion of the cattle would compare favorably with the general run of herds in the range regions of the West and Southwest. The so-called "wild" cattle, which are the descendants of the cattle first turned loose in the islands a hundred years ago, are becoming fewer every year. All of the beef cattle raised in Hawaii are grass fed.

The fattening of stock in feeding pens or stables is nowhere practiced. The result has been that, while the local ranches are able to supply enough fat beef for the local market in good seasons when the annual rainfall is well distributed and consequently there is good feed, they fall far short of being able to do so in dry years, when feed is scant. While many ranchers have spent large sums of money in sowing seeds of imported grasses on the open ranges, the practice of growing a cultivated crop of alfalfa or clover to top off for the market has not been adopted. It is undoubtedly true that alfalfa can be grown almost anywhere from sea level up to 2,500 feet elevation, even where there is not sufficient water for irrigation, although the best results would be obtained where there was an abundant supply of water. As an example of what alfalfa will do in this climate, it is found growing on the old lava flows in North Kona, Hawaii, where seed had simply been scattered broadcast from horseback. Many of the lands now used only for grazing cattle are rich enough to warrant turning them into farm lands, either to be used by the ranchers in growing crops to fatten their stock or for the use of independent farmers.

An experiment has been planned on the lands of the American Sugar Company, Molokai, not only to attempt the cultivation of alfalfa and other forage crops on fields not under irrigation, but also to improve the range, which has been impoverished by overstocking. Preliminary arrangements have also been made to build a silo in the Kula district, on Maui, with a view to demonstrate that the corn fodder grown by the Japanese and Portuguese tenants in Kula should be fed to cattle instead of being burned. A study of the native and introduced grasses, clovers, and forage plants of Hawaii has been begun.

POTATO-BLIGHT EXPERIMENTS.

The Irish potato was formerly cultivated on an extensive scale in these islands. Within the last ten years a disease has become widely prevalent which has about ruined the industry. More properly speaking, there are two diseases, one the well-known black rot of the potato, the other a wilt disease which attacks the plant while in flower and causes whole fields to wither and blacken in a single day. The black rot may be combated and in a measure prevented by the use of Bordeaux mixture. The nature of the latter disease is not understood. A preliminary experiment was undertaken in January, 1902, to determine whether there were not some varieties of potatoes that would prove resistant to the black wilt disease. The use of a plat of land in Kula, Maui, in the center of the potato-growing district, was donated to the station by Mrs. Randall von Tempsky. On this land 45 varieties of seed potatoes grown in Maine were planted. Out of this large number one variety, the June, proved to be entirely resistant

FIG. 1.—HAWAII STATION—REGISTERED SHORTHORN COW, PUWAAWAA RANCH.

FIG. 2.—HAWAII STATION—WILD CATTLE, MOLOKAI.

to the black wilt. Two other varieties were partially resistant, while the remaining 42 sorts were completely destroyed at the time they commenced to flower. An experiment was undertaken at the same time to demonstrate the value of deeper plowing and better cultivation than is commonly practiced by the Kula farmers, who plow and cultivate only 3 or 4 inches deep. This preliminary work will be continued with the hope that definite and tangible results may be obtained.

COFFEE.

A preliminary study of the coffee industry was made in December, 1901, and March, 1902, with special reference to the possible extension of this industry in Hawaii. Coffee has been cultivated in these islands for more than seventy years. A grove of trees known to be over 60 years old is still growing in a thrifty condition in Kona, Hawaii, near Kailua. The annual exports of coffee from this Territory exceed 2,000,000 pounds, and the better grades, comprising a considerable portion of this amount, are sold on merit. Hawaiian coffees, especially those produced in Kona and Hamakua, on the island of Hawaii, are of excellent flavor, and are as distinctive as the finer grades of any other land. They have a flavor entirely characteristic, which differs from that of Java, Mocha, Brazil, or Guatemala varieties. Our coffees are mild and of high flavor, and the best grades sell at prices much above the average market quotations. The establishment of the Hawaiian coffee industry on a firm basis means a great deal for the future prosperity of these islands. The coffee belt lies above the sugar belt. The climate is unexcelled, and the coffee industry is as much a white man's occupation as is the cultivation of corn or wheat on the mainland. Any measure which will hasten the day when the arable land above the coastal sugar belt is utilized for coffee or other subtropical crops will work untold benefit for Hawaii economically, socially, and politically. From 10 to 20 acres of bearing coffee will return a net income to the farmer of more than double that area of wheat, corn, or cotton anywhere in the United States. There are half a million acres suitable for coffee cultivation in these islands—enough land to support 30,000 white families. As it is to-day the lot of white settlers, especially men of small means, is hard because of their isolation. Freight rates, both interisland and transoceanic, have in the past worked against Hawaii's minor industries in favor of the dominant one. With an increase in the white population, the natural increase in trade would tend to modify this inequality. A dozen families scattered here and there through 50 miles of country are sure to encounter great obstacles in the production and marketing of crops which are in themselves of insufficient volume to support either railroads or interisland steamers; but if this same 50 miles of country can become thickly populated the conditions of life can not help but be improved. The mutual

adaptability of coffee to the land and the land to coffee in Hawaii is not a subject for argument. True, coffee has been a failure in some districts, such as Olaa, from natural causes; but when one visits Kona, on the leeward side of the island of Hawaii, or Hamakua, Puna, and Hilo, on the windward, and sees a hundred miles of coffee, utterly neglected and uncared for, and yet refusing to die, but continuing to bear large crops year after year, the adaptability of the plant to the conditions is a surprise. Coffee grows anywhere above 1,000 feet and up to 3,000. Where the fields are given the best of care, with proper fertilization, yields of upward of 2,000 pounds per acre of marketable coffee have been obtained in both Kona and Hawaii.

In view of the importance of this crop to Hawaii I would earnestly recommend that a substation for the study of the crop in all its relations be established in a suitable location on one of the islands other than Oahu. For this purpose an appropriation of $5,000 per annum would suffice. There are many problems connected with the cultivation, breeding, curing, fermenting, and marketing of coffee, as well as the diseases of the plant, which need elucidation. This station has already received several offers of land for such a substation, planted in coffee and provided with improvements, but has been unable to take advantage of any of them because of an insufficiency of funds to carry on the work. There is no doubt whatever in regard to the results to be attained. I respectfully submit that this matter should be given the attention which the subject deserves.

FIBER PLANTS.

Much attention is being paid to the cultivation of fiber plants in Hawaii. About 1,000 acres have been planted to sisal hemp, and about half of this acreage is in condition to harvest. Fiber extraction machinery has been installed on a plantation near Honolulu on Oahu, and the preliminary trials already made indicate that the fiber can be extracted from the sisal plant at a profit.

SISAL.

Sisal, or henequen, has been grown in Hawaii for about ten years, having been introduced and widely distributed for trial by the commissioner of agriculture and forestry under the monarchy. Wherever this agave has been tried it has shown marked adaptability to Hawaiian conditions. Sisal hemp thrives from the sea level up to an elevation of 2,500 or 3,000 feet. Although the claim has been made that this plant produces good fiber only when grown on calcareous soils at low elevation, I have seen many samples of fine fiber from plants grown at 2,000 feet altitude and at quite a distance from the sea. Sisal will grow with very little water on very poor soils, but it can not be controverted that far better results may be secured on fairly good land

with some water and cultivation. Irrigation of this crop when planted on rich land produces an enormous growth of leaves at the expense of fiber. The plant produces here a fine marketable fiber on upland soils which are not at all of the calcareous type, and while these fibers may sell for from one cent to half a cent per pound less than the very best grades, there is a very large market for them. There is a liberal margin of profit in sisal, but it is much like coffee in that those who attempt its cultivation must have sufficient means to stand the cost for the three or four years before the first crop can be harvested. There are fully 500,000 acres of land, now almost unused except for cattle grazing, which can be utilized in this crop. It is distinctively a crop for the leeward or dry side of the islands, for lands without an adequate supply of water for irrigation and sugar cane. There are wide stretches of such land on Molokai, Oahu, Kauai, Maui, and Hawaii.

MALINA.

Another fiber plant which thrives all over the group is "malina" (*Furcræa gigantea*), a plant reputedly introduced many years ago from Manila, and well known to the older Hawaiians, who used its fibers for making rope. Malina is even more widely distributed than sisal. It produces a fiber which, while less valuable than the best sisal or manila, finds a ready market for the manufacture of binding twine. No use is now made of this plant, but because of its having held its own for so many years in an uncultivated state there can be no doubt that anyone who would plant malina on a field scale would be well repaid for the expense involved. The best malina fiber sells within 10 to 20 per cent of manila and sisal.

OLONA.

The native Hawaiians in the days when they themselves manufactured articles to meet the daily requirements of the race utilized some of the native fibers for their ropes, twine, fish lines, fish nets, and for their garments. The very best of these was derived from the olona (*Touchardia latifolia*). Unlike sisal and malina, olona grows best in regions of great rainfall, among the rainy forests on the windward slopes of the mountain ranges, mostly above 2,000 feet elevation. It is a low shrub or woody perennial herb, seldom more than 10 feet in height. Olona belongs botanically to the same natural order as the ramie plant. Its fiber is contained in the bast of the stems. Like ramie, the fiber is of remarkable fineness and strength, but unlike that of ramie, it seems to be entirely free of gum.

In the old days every chief had an olona plantation somewhere in the mountains above the lower edge of the forest. The fiber was not derived from wild plants, but from semicultivated areas where the fern and underscrub had been cleared away to permit the better develop-

ment of this shrub. The stems of the plant were cut partially through just at the surface of the ground and were bent over or broken down so that a multitude of slender shoots or suckers should be thrown up. At the proper season these rapidly developed osier-like shoots were cut, their bark stripped off, and by the use of crude instruments the long, fine fibers were separated from the bark. The remarkable strength and fineness of this olona fiber and its resistance to the action of sea water caused it to be used for deep-sea fish lines and nets. At a later date olona entered into foreign commerce, being used for hand-made fish lines, life lines, and for similar purposes where great strength with lightness was desired. Certain of the islanders' taxes were paid in olona fiber, and it is said that this trade in olona was a source of considerable profit to the king and his chiefs.

Within recent years, through the development of trade with outside lands, olona has fallen into disuse, and the Hawaiians of the newer generation have lost all knowledge of its method of extraction and manufacture. It is possible that this fiber can be made far more valuable in the textile arts than ever before. Its cultivation does not require a large expenditure. The yield of fiber per plant and per acre is quite large, and the development of a market for it would bring into immediate utility much of the forest land above the sugar belt without entailing the destruction of the forest. The cultivation of olona fiber, if only a suitable market can be found for it, will thus mean a good deal for a zone where there are now almost no crops of agricultural value.

OLONA FIBER.

The following account of the occurrence and preparation of this fiber was supplied at my request by Dr. N. Russel, of Olaa, Hawaii:

Olona is a native Hawaiian name of a single botanical Hawaiian species of plant of the Urticaceæ or nettle family. In Hillebrand's Flora of the Hawaiian Islands we find a technical description of the plant, which is accompanied with the following footnote: "In deep ravines on all islands, but by no means common. It is the 'olona' of the natives, which yields a fiber highly prized for tenacity and durability, and is chiefly employed for making fishing nets. * * * The species, as a rule, is diœcious."

Some fifty years ago about 1,000 natives were living on the margin of the virgin forest and pahoe-hoe rock along the trail connecting Hilo town with the crater of Kilauea, island of Hawaii, in a spot corresponding to the present 22-mile point of the Volcano road. Making of "kapa" (native cloth) out of "mamake" bark (*Pipturus albidus*), of olona fiber for fishing nets out of *Touchardia latifolia*, and capturing "O-U" birds for the sake of the few precious yellow feathers under the wings, of which luxurious royal garments were manufactured—those were the industries on which they lived.

For the reasons common to all the native population of the islands, viz, the introduction of new germs of disease—syphilis, leprosy, tuberculosis, smallpox, etc.—this settlement gradually dwindled away, and in 1862 the few surviving members migrated to other localities. At present only patches of wild bananas, taro, and heaps of stones scattered in the forest indicate the places of former habitation and industry.

I have heard, however, that as late as the seventies Kalakaua still levied a tax in olona fiber from the natives of Puna and Olaa districts, which fiber he sold at high prices to Swiss Alpine clubs, who valued it for its light weight and great strength.

Touchardia grows abundantly in Olaa forests, presenting a kind of a natural plantation. It very successfully holds its own in competition with ferns and other elements of the undergrowth in the shade of "ohia" trees (*Metrosideros polymorpha*). The deep shade, very porous soil, considerable moisture, with a yearly rainfall of 180 inches pretty evenly distributed, are the natural conditions. By removing some of the undergrowth, scattering seed, and probably by planting cuttings, the number of plants on the same area could be greatly increased with but very small expense. Since plants of medium age (about 18 months old) supply the best fiber, natives in gathering used to turn down the older ones with the foot, laying the whole plant on the ground to force new shoots and sprouts.

MANUFACTURE.

I was familiar with the plant and its properties for years, but did not pay any further attention to it as a possible object of industry for the reason that to all appearances the same difficulties in mechanical extraction of fiber will be met as in the case of ramie, for which no satisfactory machine has been found. Recently my interest in the matter was again aroused by Mr. Jared G. Smith, of the Hawaii Experiment Station. Considering that Touchardia seems to be free from resinous matter, upon his suggestion I decided to examine the subject more in detail. For this purpose an old native, born and raised in the settlement above mentioned, was interviewed. Together with him I proceeded into the forest along 22 miles side trail. In my presence he picked the plants, stripped them of the bark, and with his own olden tools manufactured the sample of fiber.

My object was to ascertain what kind of plants he selects, and to see the primitive method of manufacture, with the idea that this method might furnish some suggestions for the construction of the machine. We had hardly made a dozen steps in the woods along the 22-mile trail when a rich harvest of Touchardia was found. We found both male and female plants that could be distinguished only by inflorescence. Whereas male flowers are situated on relatively strong, repeatedly forking cymes, growing out of the base of the leaves, female ones look like so many flattened lumps of green dough planted at the base of the top branches. Both plants are taken indiscriminately. Careful discrimination is made, however, in regard to the age of the plant; neither too young nor too old ones are taken. The bark of old ones is somewhat knotty, woody, and short jointed, and, as I have mentioned, such plant is turned down to the ground to force it to give new shoots. The best stems are not thicker than the finger, about one year and a half old, with the bark of a chocolate-brown color, with distanced scars of former leaves, straight and high (8 to 10 feet), devoid of leaves except on the top. Such stems are cut with the knife near the root and below the crown. Their bark strips easily as a whole from bottom to the top. The ribbon obtained is hung over the neck of the gatherer. There is also a plant with the leaves very much like those of Touchardia, the "hopue"; but this one generally grows to a large sized tree, has different flower, and light-grayish color of the bark. Neither previous soaking nor drying are resorted to before the extraction. The bark is used raw.

The implements used are: (1) A wood board made of "naou" tree, characterized by its dark color, hardness, compactness, evenness, and absence of knots. This board is about 6 feet long by 2 to 3 inches wide. It has a very light curve in both directions—in width and length; is wider at one end and obtusely pointed at the other. (2) A plate of fish bone of "honu" fish, about 8 inches long by 2½ wide, and is also slightly curved in both directions. Its lower margin is sharpened under 45° like the edge of a chisel.

The process of manufacturing is as follows: The "naou" board is fastened on the ground with rocks at the narrow end to prevent any forward sliding, the curved surface uppermost. The broader end is a little elevated by another piece of rock. The board is moistened with water. A ribbon of bark from one plant is taken. Its bottom end is first fastened by treading on it with the toe of the right foot, the top end raised vertically by the left hand, so as to tightly stretch the band. Holding the fish plate by the right hand in its middle, the sharp end of the bone is passed upward along the inner surface of the ribbon, which operation is intended for flattening the curled ribbon and taking off the slimy substance covering the inner surface. Then the ribbon is stretched horizontally upon the naou board, the bottom end toward the wider end of the board and the operator, and held tightly to it by the two fingers of the left hand, the outer surface of the bark upward, the inner sticking to the board. Then the fish plate, held in the right hand by the middle at 45°, with its sharp end downward and forward, squeezing the ribbon between the tool and the board, is repeatedly passed toward the pointed end of the board, by which motion the flesh is scraped off, leaving a ribbon of fiber. From one to two minutes are required to free the bark of one plant. The operation of scraping is easy, the fiber evidently being located on the inner surface. The fiber thus obtained is dried in the sun.

Besides manufacturing fishing nets, natives used to make of it the best of their fishing lines. I am told that whalers in former times paid high prices for olona for making lines for whales. There is an old native in Hilo who still uses the line that was made and used by his grandfather.

FRUITS.

Although there are large quantities of fruit imported from the mainland, especially those of the temperate zone, there are some which here attain a degree of perfection not approached in any portion of the United States. We have also some fruits which are distinctively tropical, a market for which may some day be developed on the mainland.

PINEAPPLES.

A pineapple cannery is now in successful operation on the lands back of Oahu plantation. Two new companies have been formed at Wahiawa, Oahu. The total area planted is about 1,000 acres. This fruit seems to be especially adapted to island conditions, and there is still a great deal of land available for pineapple cultivation.

I append a paper by Hon. Byron O. Clark, of Wahiawa, relating to this new industry:

Pineapples seem to be one of the crops especially suited to our local conditions, having no destructive insect pest, imported or native, to prey upon it; thriving through drought, producing even better quality of fruit than during wet seasons; easy of propagation and cultivation and responsive to good culture, which, with a certain amount of fascination that attends the production of all tropical fruits, place it well up among the popular fruits destined to figure in the horticultural history of Hawaii in the near future.

The growing demand for the fruit on the mainland and for ships' supplies, both in the fresh and canned state, leads me to consider it a safe and profitable crop, as well as being otherwise suited to the conditions of the small farmers of the islands. With

the advent of canneries here, this one industry can be made a source of revenue—through the employment given in growing and packing the fruit—sufficient to assure the future prosperity of this colony.

It is very gratifying to be able to speak hopefully of this industry, as we hear so much of a pessimistic tone regarding the possibilities for the small farmer making a living here. It now looks as if we would soon be able to give ocular demonstration so convincing that the class of people who always beset new countries, belittling the opportunities and discouraging home makers, will have to find a new topic to "harp" on. For even with one anchor crop (and I believe there are other industries, including sugar cane, that will be developed into paying industries suited to the small farmer) the prospect is good.

If I may be allowed to digress, I wish to state as my candid belief that in less than five years we shall hear less of the cry, "small farmers can't grow cane," for they not only can but will, if given a chance, and will be the salvation of the sugar industry from the disaster that pessimists are endeavoring to claim for it.

As to pineapple culture—it is much like other branches of horticulture—there are "many men of many minds," and consequently considerable divergence of opinion as to methods. My own experience for the past four and a half years convinces me that when land is not limited to very small tracts, wide planting between the rows—in order to permit cultivation by horse instead of hand labor—is best. While one gets a lesser number of plants on a given area, it is much easier to get among them for hoeing, which is limited to the immediate vicinity of the plant, and for harvesting the fruit and removing the suckers for new plantations. Then, there is a better chance for perfect development, and the cropping period of the land certainly will continue longer with 3,000 plants per acre than with three times that number, as is frequently done by the advocates of close planting. I have demonstrated to my satisfaction that the breaking of the fruit from the stem is prevented by wide planting. I think it is caused by insufficient nourishment, and instead of close planting preventing it, as is claimed, it aggravates the trouble, unless the plants are so very close together that the fruit is held in place, and such planting soon leads to deterioration of the quality of the fruit. You can no more continue taking three fruits from the space that one needs with the pineapple than you can with the peach, orange, or other fruits. Excessive crowding is always at the expense of quality if not of quantity, and generally of both when net profit is figured. Then, too, crowding of any plant, leading to weakening of the vitality, encourages the ravages of insect pests. With the close, crowded condition of many plantations it is difficult to get among them for applying insecticides, and the dense, crowded mass of plants becomes a veritable hotbed for all kinds of scale and for mealy bugs, if they once get a foothold.

FIGS.

Figs thrive luxuriantly in all the districts of the islands below 5,000 feet elevation. They seem especially thrifty in the leeward regions, such as Kona, Hawaii. They bear large crops of fruit of uniformly fine quality from January to August. There are no destructive diseases, and few pests other than the honeybee and the mina bird, both of which are fond of the ripe figs.

A fig cannery would find in many districts a sufficient supply of fruit to keep it in operation six months in the year. Such an enterprise would give the growers a local market, whereas now there is no market, since ripe figs do not bear shipping. In parts of Kona, Hawaii, the

enormous crops of fruit borne by the trees are either allowed to rot or are fed to pigs. I believe that here is a small industry which will prove lucrative both to the grower and to the canner.

PAPAYAS.

The papaya is well known to Florida horticulturists, and to a certain extent in the New York fruit markets as well. As a breakfast fruit it has few equals. Not only is it excellent for the table, but it also has medicinal value. The leaves, seeds, green fruits, and the milky juice of all parts of the plant contain a vegetable pepsin "papain," which when properly prepared is of medicinal value. There are two general types of papayas grown in Hawaii. One with elongated fruits was introduced from Ceylon within recent years. The more common variety has fruits which are oval, often as large as a medium sized winter squash. The papaya grows well in almost any soil or in rocks where no soil is to be seen. The fertile trees begin to bear when 8 to 12 months old and fruit continuously for two or three years.

Papayas are a very good money crop, because the fruits ship well and bring a good price in the local markets. They also begin to make some return for the investment earlier than in the case of most tropical products. Fine jams are made from ripe or partly ripe papayas. A Honolulu manufacturer prepares from the partially ripe papaya a very excellent candied fruit, which is used locally as a substitute for citron. The powdered seeds are especially useful in treating cases of chronic indigestion. The ripe fruits are a good feed on which to fatten hogs. So it will be seen that the numerous uses of this fruit make the plant a good one for cultivation by men with limited areas of land or small means.

GUAVAS.

The guava is so abundant that it has become almost a curse in Hawaii. It is very difficult to rid land of guava bushes because of the creeping underground stems and roots. However, this plant may be considered an index of rich land, as it grows only where the soil is of the finest. Guavas bear from two to three crops per annum, or in some cases fruit continuously. But little has been done with this tree in Hawaii, but a few cultural experiments indicate that if the guava was given orchard cultivation, with careful pruning, the quality of fruit could be easily improved and the yield much increased.

The demand for guava jellies and guava jams is on the increase in the United States. There are many localities where the crop which now rots on the ground might be gathered at little expense and used for the manufacture of these delicious articles. Besides the fruits, the wood is valuable for making charcoal and the bark is used by local tanners.

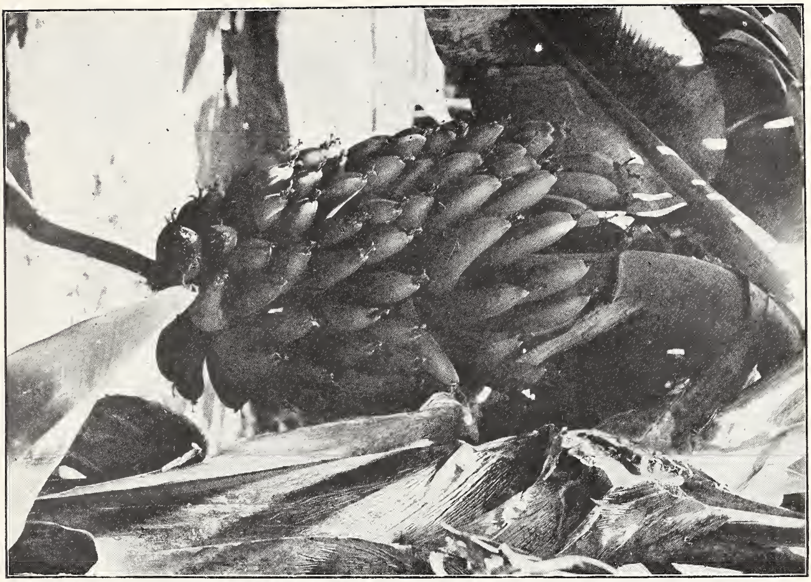


Fig. 1.—Hawaii Station—Bananas.

Fig. 2.—Hawaii Station—Alligator Pears.

Fig. 1.—Hawaii Station—Orchard Plantation, Station Grounds.

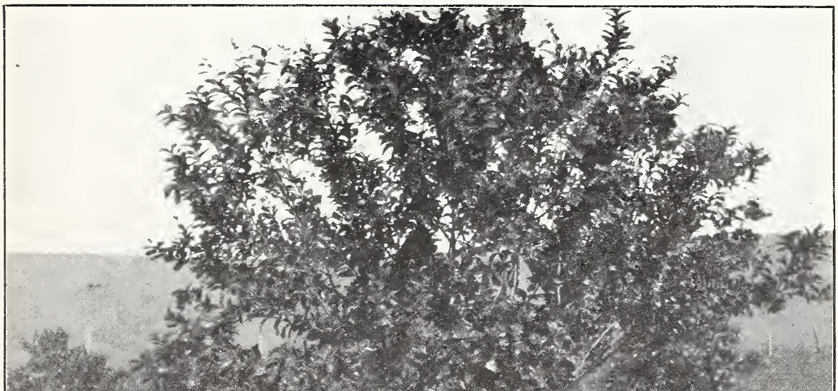


Fig. 2.—Hawaii Station—3-year-old Lemon Tree, Punwaawaa Ranch.

MANGOES.

A great variety of mangoes is cultivated in the Hawaiian Islands. The tree is one of the most beautiful, because of its dense foliage and symmetrical form. It thrives from sea level up to about 1,500 feet elevation, and must be planted where partially protected from the full sweep of the trade winds. The ripe fruits are often of excellent quality, the flavor being more pronounced than in many other tropical fruits. They are also eaten cooked, both green and ripe, and the chutney varieties are pickled. Elsewhere in the Tropics mangoes are given orchard cultivation, and the soil around them is fertilized after a crop of fruit has been harvested. The tree grows best in well-drained soil, and if the tree is made to rest and ripen its wood it will yield annual crops. The fruit is best when ripened off the tree. The mango ships well. It is a promising crop for cultivation on a large scale in Hawaii for shipment to the mainland.

ALLIGATOR PEAR.

The "avocada," or more commonly called "alligator pear," is a fruit which grows well in sheltered localities up to 2,000 feet. The tree is even more susceptible to damage by high winds than the mango. The fruit is eaten as a salad, with salt, vinegar or lime juice, and pepper. It is considered very healthful. There is much difference in the quality of the fruit in different varieties, as also in the form and size. The local markets consume all the alligator pears offered. When of good quality the fruits bring high prices. They ship well in cold storage, and the mainland markets might well be catered to by Hawaiian orchardists.

GRAPES.

Grapes are grown for the local market, and in isolated sections for wine making. Out of 50 varieties which were experimented with some years ago, the Isabella seems to be best adapted to island conditions. Other varieties have been grown with success. The trellis system of growing grapes is the only one used at present. Grapes sell in the markets for from 10 to 15 cents per pound.

LIMES.

Limes thrive in the upper gulches and upper valleys of all the islands. The fruits are large, smooth, and thin-skinned and full of juice. Unlike island oranges, they are comparatively free from skin blemishes. The trees bear the year round. Limes sell for 15 cents a dozen in Honolulu.

PEANUTS.

Peanuts were cultivated at one time principally for the oil. At present they are grown to a limited extent to partially supply the local demand as a nut. The crop is well adapted to many of our soils. While the nuts are small they are sweet, and by the introduction of new varieties possibly a larger nut could be secured.

ABANDONED INDUSTRIES WHICH DESERVE ATTENTION.

COTTON.

Cotton was introduced into the islands in the early part of the last century, samples of it being sent to China by Kamehameha the Great. The staple was of good quality, and the fabric made from it was strong and heavy. The plant in this latitude is a perennial. The varieties that have been grown here are Sea Island, Georgia, and Peruvian. Cotton was an article of export during the years of the American civil war.

CASTOR BEAN.

The castor-bean plant has been growing in the Hawaiian Islands for so many years that it is now a roadside shrub. The plant is here a perennial tree, often reaching the height of 30 feet with a trunk 12 to 20 inches in diameter; whereas, in the temperate regions, it is an herbaceous annual. It can be seen at almost any elevation and in most localities. Its cultivation for commercial purposes has not received much attention.

On good soil an acre of castor-bean plants will yield 2,500 pounds of beans annually. The commercial life of the plant is from five to seven years, and as yet no serious pest has appeared to injure its growth. There is a ready market for the beans in Honolulu at from \$50 to \$60 per ton. Lately the industry has been receiving more attention from farmers. One fully equipped mill for making the oil from the beans has been erected. The oil is used for lubricating purposes, is of good quality, and sells at from 90 cents to \$1 per gallon. Castor beans and papayas grow well together. The combination of these two trees in an orchard reduces the cost of harvesting, as both crops may be gathered at the same picking. This plant grows on a great variety of soils, and much uncultivated land might well be planted to castor beans.

PIA, OR CASSAVA STARCH.

The manufacture of starch from the manioc plant is an industry which has attracted the attention of farmers in the Hawaiian Islands for a number of years. This starch, known locally as "pia," is highly esteemed by the natives both for laundry and cooking purposes. Pia starch sells in Honolulu for from 7 to 10 cents per pound retail. The

FIG. 1.—HAWAII STATION—COTTON PLATS.

FIG. 2.—HAWAII STATION—CASTOR BEAN TREE, 25 YEARS OLD.

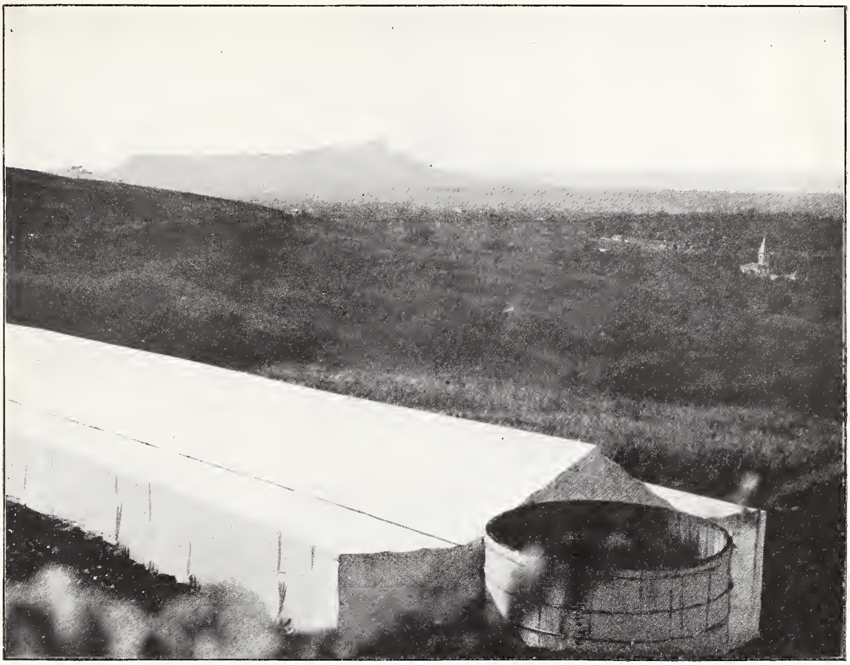


FIG. 1.—HAWAII STATION—NEW PLANT HOUSE, MUSLIN COVERED.

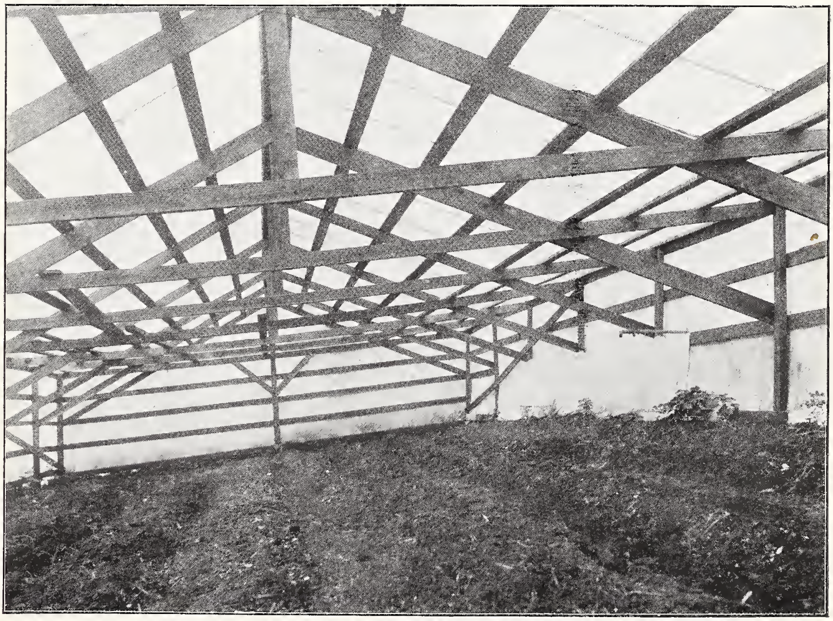


FIG. 2.—HAWAII STATION—INTERIOR OF NEW PLANT HOUSE, SHOWING CONSTRUCTION.

demand is constantly increasing. The adaptability of the soil and climate of the Hawaiian Islands to its culture would indicate that the demand can be indefinitely supplied.

The processes of manufacture are generally primitive. In the method commonly employed the root is washed and grated by hand graters. The pulp thus made is placed in water, the mass thoroughly stirred, and the whole allowed to settle. The water is then drawn off and the residue, which is starch, is washed and dried. The refuse from the starch mill is fed to pigs. It is a fattening food and contains considerable nourishment. The manioc plant thrives on all the islands of the group. It does not require the attention that many crops do, and it is comparatively free from pests. The chief obstacle in the development of this industry at present seems to be the lack of modern mills.

ENTOMOLOGICAL INVESTIGATIONS.

The annual loss in this Territory through the depredations of insect pests far exceeds the average of other districts of the country. The vast number of injurious species present here is one of the greatest obstacles in the development of Hawaiian agriculture. The large areas of uncultivated lands give the pests unrestricted opportunity to develop in numbers sufficient to discourage the cultivation of plants in the vicinity of such areas. A more complete cultivation will help to solve this side of the problem. The insects have been introduced from abroad, where in many cases they have been kept in check by climatic conditions and their natural enemies. Here, relieved of these natural checks, they have multiplied in unlimited numbers and the small area of the islands has permitted their rapid spread.

The fruit industry is not at present developed to any importance. The greatest injury occurs to field crops. The general use of insecticides is nowhere practiced in this Territory. Precautionary measures are, in the main, the most important in the cultivation of field crops. These are thorough and clean cultivation, proper time of planting, the use of fertilizers to produce a vigorous growth, the clearing away and burning of all rubbish, and the keeping down of all weeds in the vicinity of cultivated places. When a pest is established and the plant is not able to resist the attack, the use of insecticides must be employed.

An immense amount of scientific work has been done on the Hawaiian insect fauna, but as yet the only steps taken to check the ravages of the injurious species have been the introduction of their parasitic and predaceous enemies. This is valuable work and highly desirable, but it is not certain that an introduced parasite will confine itself to one special host.

The introduction of the parasitic and predaceous enemies of our injurious insects is very important, and the Territory is especially

fortunate in having in its employ experts working along this line. The introduction of such species, together with a more extensive cultivation, will bring the number of herbivorous insects down to a normal ratio and render the use of precautionary measures and insecticides more feasible. Where the pests occur in almost countless numbers, as they do in the center of great areas of uncultivated lands, the task of combating them seems hopeless. With the cultivation of greater areas and with the presence of natural enemies, the number of injurious insects will be greatly lessened. Wherever the cultivation of plants favors the development of plant-feeding forms and destroys the natural breeding places of their enemies, artificial means must be employed to counteract the effect. For this purpose the application of insecticides has come into general use throughout the United States and other countries.

This station is supplied with the standard remedies for insect pests, and will endeavor to adapt their use to the local conditions. The frequent local rains will make it necessary to spray more often than in other countries and demand the use of mixtures not easily washed away. The absence of long seasons of extreme cold or dryness will force the operator to be more persistent in his efforts, because of the lack of these natural aids. In the spraying of trees, the fact that they remain in leaf throughout the year will prevent the use of the more active insecticides applied successfully during the winter in the temperate zone. These and other conditions must be considered and recommendations made accordingly. The question of legislation has been suggested in combating some of the more serious pests in certain districts of the islands. This is not a political question, but rather one of education.

As has been already stated, the damage to the field crops is the most important loss. The aphis all but ruined the 1902 crop of corn on the island of Maui. It was preyed upon by two of its natural enemies, a ladybird and the aphis-lion, yet in certain fields the leaves looked as if a fire had swept over the place. Precautionary measures were prescribed. Corn had been planted in this district year after year for the past 20 to 40 years without change of crop or seed. Deep plowing had not been practiced and the use of fertilizers to strengthen the plant to resist the attack had not in any case been employed.

Several small farms on the island of Hawaii were abandoned last year because of the cutworms (three species of Noctuidæ). These pests are widely distributed over the islands. It is a saying among the farmers that they "can raise four crops a year—one for themselves and three for the cutworms." On limited areas it is believed that these pests can be kept in check.

A fly is doing great damage to the cucurbits by stinging and depositing its eggs in the young fruit. The larvæ on hatching burrow into

the tissue, causing decay. As a result a good watermelon brings from 50 cents to $1 on the fruit stands of Honolulu.

Stockmen are greatly troubled over the presence of the horn fly. Cases have been reported where death of the animal has been the result of its attack, but there is no doubt but that lack of water and the proper amount of food helped to bring the fatality about.

Several hundred thousand dollars' worth of sugar cane is destroyed yearly by certain pests of that plant. Most of the damage is wrought by a borer, the larva of a beetle (*Sphenophorus obscurus*).

The trees of the Hawaiian Islands suffer continually because of the presence of an unusual number of scale insects, plant lice, and mealy bugs. One species of the latter pest (*Dactylopius* sp.) is at present doing great injury to the alligator pear, or avocada, in the vicinity of Honolulu. Many trees have died and all are injured to a greater or less extent. The application of kerosene emulsion has been used with success in several instances and will be advised as a remedy, together with proper pruning and cultivation.

A most destructive pest to grapes, roses, and all shrubs in general is a beetle living on the foliage, called, on account of its injury to the roses once grown here in abundance, the Japanese rose beetle (*Adoretus umbrosus*).

The list of household pests is a long one and includes ants, cockroaches, termites, silverfish, clothes moths, and mosquitoes. The number of such pests here in the Tropics is unusually large. The most serious of this class is the mosquito. The only way comfort can be obtained is by screening the houses. This method and the burning of pyrethrum are the only measures taken against this pest. The measures so successfully carried on in certain parts of infested regions of the United States in exterminating the mosquito during the immature stages of growth will be advocated here.

The station has purchased for the use of this Department the standard works on economic entomology and procured the various publications of the Division of Entomology at Washington and the State experiment stations of the country. A laboratory fitted with the necessary apparatus to carry on breeding experiments is now a part of the equipment. Microscopes and other apparatus, together with collecting supplies, have been purchased, and a collection of Hawaiian insects is well under way. Several styles of spray pumps, thought to be especially suited to the work, have been purchased. One pump and outfit has been donated to the station for trial. These will be given a thorough test and reported upon. The entomologist is also supplied with a photographic outfit to be used in obtaining illustrations for publications and for lantern slides for use at farmers' institutes and in lectures to illustrate the life histories and work of the insect pests.

DISTRIBUTION OF SEEDS.

During the fiscal year 1901–2 many seeds have been sent out by this station for trial. These were mainly of various forest trees having some valuable economic quality, such as the cork oak, pistache nut, carob bean, divi-divi, teak, and some of the Australian eucalyptus species not already in common cultivation. A collection of vegetable seeds received from the Bureau of Plant Industry was distributed in small lots among a number of the common schools of the Territory for use in the local agricultural nature-study work. Much has been done in getting seeds of tropical and subtropical economic plants for the use of those who wished to try them.

CORRESPONDENCE.

So far as possible, assistance has been given to all who have applied for information in regard to agricultural problems in this Territory. This has entailed much letter writing. About 500 such communications have been answered during the year, and as no provision has been made for clerical help, much time has been given to this side of the work by the special agent in charge and his assistants.

WORK FOR OTHER DEPARTMENTS.

At the request of the commandant of Camp McKinley, acting through the Secretary of War and the Secretary of Agriculture, 1 acre of ground on the lower portion of the station has been set apart for a propagating nursery for starting trees to be used at the new military post west of Honolulu. This ground was plowed and water pipes laid. The cost of labor and other expenses in connection with this nursery are borne by the War Department, but the selection of the trees and plants and the general supervision and direction of the work has been carried out by the special agent in charge of this station.

The agriculturist of the station has received many calls for assistance from the collector of customs and the collector of internal revenue during the year, and has made many chemical and technical examinations of drugs, liquors, cereal products, and textile fabrics for these two offices.

IRRIGATION.

On January 1, 1902, the special agent in charge was instructed to investigate and prepare a report upon the cost of pumping water on the various sugar plantations on these islands. Pursuant to these instructions, letters of inquiry were directed to plantation managers, and a tour of inspection was made to the Baldwin group of plantations on Maui and the principal plantations on the island of Oahu. A report was prepared and submitted embodying points relating to the

following subjects: The chief hydrographic features of the islands and the source of the water supply; the relation of forests to irrigation; the classes of pumps used, and complete details of the pumping machinery and cost of operating the same on Oahu and Ewa plantations on the island of Oahu, and Haiku, Paia, Hawaiian Commercial, and Kihei plantations on Maui.

COLLECTIONS.

An herbarium of both native and introduced plants has been begun. About 1,500 specimens, mainly collected on the experiment station grounds and in the environs of Honolulu, are now in this herbarium, and others are being added as opportunity allows.

THE FARMERS' INSTITUTE OF HAWAII.

The farmers' institute work was started in Hawaii in January, 1902. Through the efforts of the officers of the United States experiment station in Hawaii, a meeting of those interested in such a movement was held on the evening of January 25 at the residence of Mr. B. O. Clark, at the Wahiawa colony, Oahu. At this meeting the following officers were elected: President, Jared G. Smith; vice-president, T. F. Sedgwick; secretary-treasurer, D. L. Van Dine. The purpose of the meeting was to organize a permanent society to help the farmers throughout the Territory and encourage the founding of permanent homes in Hawaii.

The members of the newly formed institute were encouraged to proceed with their plans by the following letter from the governor of the Territory:

EXECUTIVE CHAMBER, TERRITORY OF HAWAII,
Honolulu, January 24, 1902.

THE FARMERS' INSTITUTE.

GENTLEMEN: It is with great pleasure that I have learned of your intention to organize a farmers' institute upon a permanent basis. It is an enterprise which, if perseveringly conducted, can not fail to be of great benefit to the farming interests of the Territory in distinction from sugar-planting interests. Your success will doubtless stimulate the formation of similar associations in other parts of the islands.

I notice in the newspapers some doubt expressed as to the practicability of profitable farming in the Territory. I have no doubt on the subject; and it is by such organizations of farmers' institutes, intelligently and enthusiastically carried on, that the success of diversified agriculture will be most effectively promoted.

I recognize the probability that general farming here must develop slowly. Individuals here and there will succeed because of intelligent and skillful cultivation of the soil and a careful study of the markets. Farmers' institutes will promote such cultivation and such study of the markets among the whole farming fraternity.

I need hardly remind you of the extent to which our political future depends upon the growth of a farming class in these islands, living on and making their living from their farms. If we fail in this, and the agricultural work in the Territory shall be confined to large estates cultivated by a floating element of cheap laborers having no interest in the soil, the prospect of building up a citizen population of a conservative and intelligent character will be poor indeed.

I wish to call your attention to the intention of the government to hold an exhibition of agricultural, horticultural, and floral products in the month of July of this year, and to invite your members to compete in such exhibition.

I wish your enterprise all success.

Very sincerely, SANFORD B. DOLE.

This society is not the first one to be organized for the promotion of agriculture in Hawaii. Such organizations have been in existence for the past half century. For one reason and another they have passed out of existence, the most important reason being perhaps that the country is dominated by one great industry, the raising of cane, beside which the lesser industries have had little attention or encouragement.

For the past four years persons interested in such a work have sought to establish an organization on the plan of the farmers' institute, but each year have met with failure. This year has seen the first successful attempt to bring the farmers of the Territory together and unite them in one effort to build up and broaden Hawaiian agriculture.

The idea of institute work has been well carried out; the informal meeting of the scientific and the practical agriculturist on a common ground in order that the experimenter may learn the difficulties and needs of the latter and the practical farmer may learn the underlying principles connected with the operations of the farm and field and gain a solution of the problems which daily confront him; in other words, to learn how to apply to his work the results of scientific investigation.

Six sessions of the institute held during the year have been attended by members of the station staff, three at the Wahiawa Colony, Oahu; one at Honolulu, and two on the island of Hawaii—at Hilo and at Mountainview. While in each case the meetings were local in their scope, especially the discussions, yet the papers presented treated of the subjects in a way applicable to the Territory in general. The discussions were made the important part of each programme.

Subjects on which papers were prepared by men best fitted by experience to write them are: Forage crops; the relation of the experiment station to the farmer; the pruning and cultivation of fruit trees; the possibility of the agricultural development of the different farming districts of the islands; stock raising; the castor bean; pineapples; potatoes; the fertilization of fruits and vegetables; vegetable gardening; and the possible products for export.

Since its organization the Farmers' Institute of Hawaii has had a steady growth. Men not directly connected with agriculture, as well as the latter class, but interested in the agricultural development of the Territory, have placed their names on the roll of active members. The interest shown indicates that the society is permanent and in the future will be a factor in the promotion of agriculture in the islands.

As a result of the preliminary meetings held at Hilo and Mountainview, on the island of Hawaii, permanent organizations holding monthly meetings have been formed at each of these centers.

CLIMATE.

While the temperature of the Hawaiian Islands is as a whole quite uniform, there are local conditions that give the country many variations. The island climates have been classified by Prof. C. J. Lyons, Government meteorologist, as follows: (1) The weather side trade-wind exposure; (2) the lee side trade-wind exposure; (3) the strong trade region; (4) the lee side land and sea breeze; and (5) the weather side land and sea breeze.

A few hundred feet altitude, an exposed position to the wind, a few more inches of rain, or a few degrees in temperature are sufficient to cause a different climate. Some localities have much wind and rain, others wind without much rain, and still others rain without much wind. The valleys, plains, plateaus, gulches, and mountains all have a climate peculiar to themselves.

The general climate of the islands is said to be due to the trade winds and the phenomena caused by the mountains, which affect the rainfall.

RAINFALL.

The rainfall is extremely variable. In some sections the average for the year may not be over 20 inches, while in others it is almost 200 inches. Between these extremes there are many variations. Along the coast lines of Oahu and Hawaii the variation is from about 20 inches at Kawaihae to 127 at Waiakea, a variation of over 100 inches at not greatly different elevations.

The amount of rainfall does not necessarily increase with the elevation, although it frequently does so. The effect of elevation on increased rainfall is well shown along the mountain slopes of Haleakala, Maui. Starting at Kahului, at sea level, with an annual rainfall of 14.63 inches, the total of precipitation increases rapidly with the elevation, and Puuomalei, at an elevation of 1,400 feet, has a rainfall of 59.29 inches. This change takes place in a distance of about 10 miles. Beyond this point there is a decrease in the total precipitation toward the center of the island. On the island of Hawaii there is an increased rainfall from Hilo toward the summit of the volcano Kilauea until an elevation of 1,650 feet is reached. Here the precipitation is 177.98 inches. At Volcano House, where the elevation is 4,000 feet, the annual rainfall is but 75 inches. Important variations within short distances at nearly the same elevation are noted. As an example: At Kapiolani Park, a suburb of Honolulu, with an elevation of 10 feet, the rainfall is 22.94 inches, while at Honolulu, elevation 15 feet, it is

29.79 inches. The distance between these two points is not over 3 miles.

Frequent light local showers are characteristic of the Hawaiian climate. They often seem to come from a clear sky, and it frequently happens that one locality may be drenched by a sudden shower while a few hundred yards distant there has not been a drop.

WINDS.

The prevailing wind is the northeast trade. It blows on an average 260 days in the year and is one of the chief agents in making the climate of Hawaii what it is. The trade winds being strong and cool, not only moderate the heat, but influence the health of the inhabitants of the islands. Devastating winds are of rare occurrence. There are light sea breezes and occasionally a "kona," which is a severe southwest wind. November is the special season for the kona, which in some sections causes considerable damage. The rainy season extends from November to March. Electrical disturbances are occasional, but not severe.

TEMPERATURE.

The temperature is not so variable as the rainfall, but a few degrees either cooler or warmer in this latitude make a great difference in the feeling and comfort of the individual. The following figures show approximately the variation in temperature according to the elevation at the several stations on the island of Hawaii:

Range of temperature in Hawaii.

Elevation.	Temperature.		
	Maximum.	Minimum.	Average.
	Degrees.	*Degrees.*	*Degrees.*
100 feet	84	64	73
585 feet	85	66	74
2,720 feet	82	57	70
4,000 feet	75	....	65

At Honolulu the average temperature is 74° F., with extremes of 88° and 54° and a daily range of 11°. Occasionally the mercury goes 1° or 2° higher or lower. The daily range usually increases toward the higher elevations, where it approaches that of the temperature of colder countries, ranging from 16° to 20°.

The average relative humidity is 72 per cent, which is low for the Tropics, and to this fact may be attributed much of the salubrity of the climate.

ANNUAL REPORT OF THE PORTO RICO AGRICULTURAL EXPERIMENT STATION FOR 1902.

By F. D. Gardner, *Special Agent in Charge.*

INTRODUCTION.

This, the second annual report of the Porto Rico Agricultural Experiment Station, presents the present status of the station and gives in general terms the progress and results of the principal lines of work for the year which has elapsed since the first annual report was made. The first report was printed as part of the Annual Report of the Office of Experiment Stations, and also issued as a separate or reprint of the same. At the time of its preparation the station had not secured a site for a permanent location, and in view of the probable delay in securing a suitable site arrangements had been made and work commenced in carrying out a temporary series of field experiments at Rio Piedras, near the capital. This work was vigorously pushed for several months, but the grounds and experiments were abandoned in August of the present year and the station moved to its permanent quarters at Mayaguez.

The United States Congress made an appropriation of $12,000 for carrying on the work for the present fiscal year. The insular legislature came to the aid of the station and appropriated $15,000 for the purchase of land, while the municipality of Mayaguez donated $4,000 additional for this same purpose, thus making the total income for the station for the present fiscal year $31,000.

The soil survey, which was undertaken in cooperation with the Bureau of Soils in January, 1902, has been completed, and the resulting maps and manuscript are ready for the printer. This will first be issued by the Bureau of Soils in its annual report, after which it will be translated into Spanish for the use of the experiment station.

The station staff, which at the time of the last report numbered only three, has now been increased to five, the two additions being a coffee expert and a clerk and stenographer.

PERMANENT LOCATION.

The need of a suitable tract of land on which to permanently establish the agricultural experiment station was presented to the insular

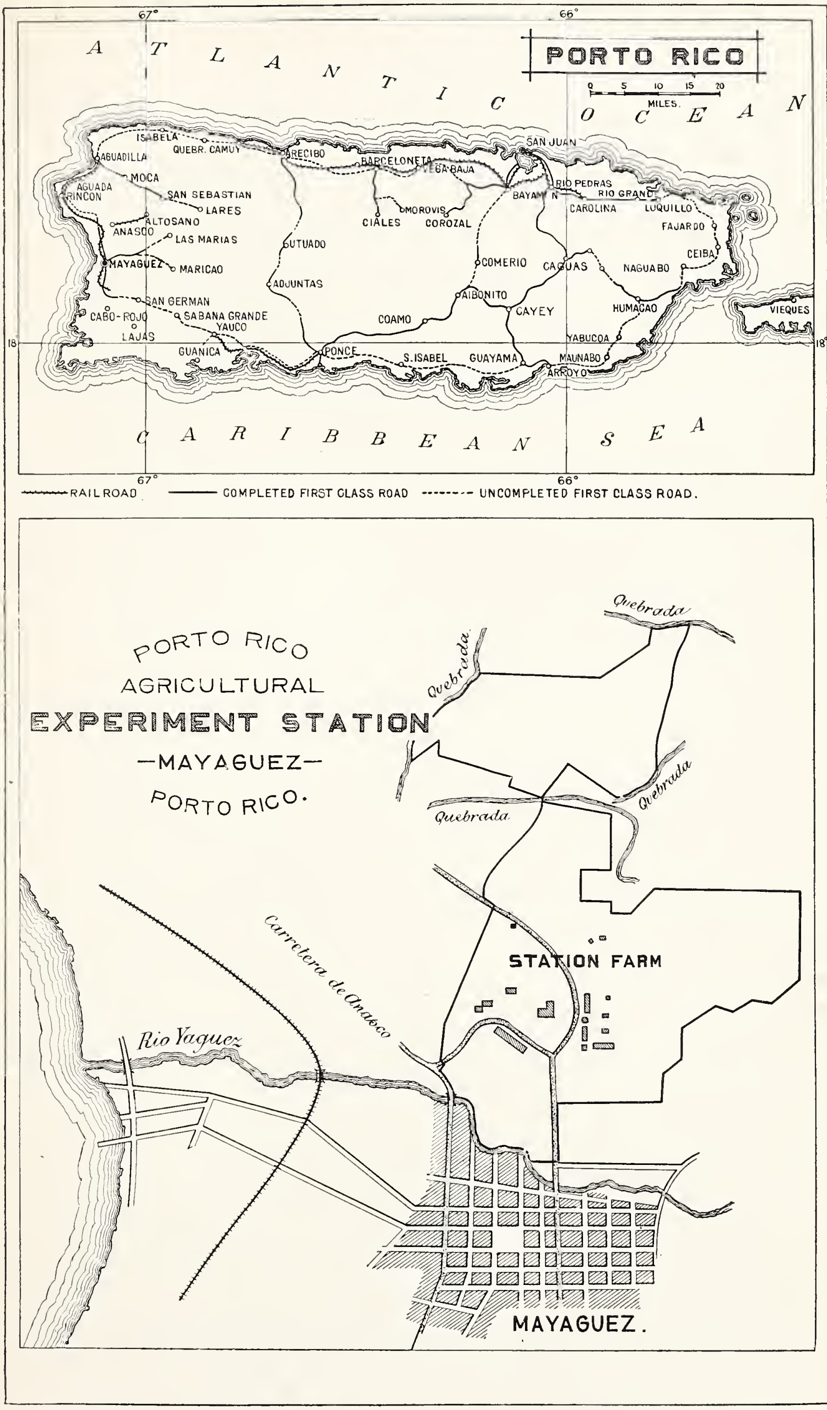
legislature in February, 1902, and the bill making immediately available $15,000 for the purchase of such a site passed both houses with very little opposition. Bids were called for in March, which were to be opened the 12th of May. On the latter date, Dr. Walter H. Evans, of the Office of Experiment Stations, who had been authorized by the Secretary of Agriculture to proceed to Porto Rico and act with the representative in charge of the station, conferred with the governor and the secretary of the interior of the island with reference to selecting a site as offered by the bids.

Twenty-three proposals were received in proper form, and those that were obviously best were visited by the committee and examined with reference to their suitability for the purpose, the result being the selection of a site adjacent to the city of Mayaguez. This proposal had been submitted by the city itself, it having secured an option on a tract of land for $19,000, the excess over the appropriation to be paid by the city. Possession of the land was given the last week in June, and the experiment station removed from Rio Piedras to its new site the first week in September.

DESCRIPTION OF FARM.

The farm, embracing 235 acres, formerly known as "La Carmen," is located near the city of Mayaguez. A portion of the river-bottom land borders the river Yaguez and the main road to Anasco. The map (Pl. XXVIII) shows its form and location with reference to the city and the "playa." The land is diversified in character of soil, topography, and exposure. There are about 35 acres of river-bottom land (Pl. XXIX, fig. 1) nearest the city, which contain a deep loam, to the depth of 3 feet or more. This, at present, is all in "malojilla" grass. The land to the north of this consists of low, rounded hills and intervening valleys and coves (Pl. XXIX, fig. 2), many of which are well sheltered and well watered. In various sheltered places coffee is planted, there being in the aggregate about 7 acres planted to that crop; the remainder of the land is largely in an unproductive condition, being overgrown with weeds, bushes, and small trees, intermingled with a small amount of various kinds of grasses, which would furnish some pasture. Although in an unproductive condition, the place presents very good possibilities and is well suited to the purpose of the experiment station.

The main residence, a frame house of 11 rooms, has been put in repair, painted both inside and out, and is occupied as living quarters (Pl. XXX, fig. 1). An old masonry sugar building, a large part of which was unroofed, and the walls of which were more or less broken and damaged, has been repaired, roofed, and painted both inside and out, and will serve the present needs of the station for office, laboratory, and working quarters (Pl. XXX, fig. 2). There is a brick factory



PORTO RICO STATION—MAP SHOWING LOCATION OF THE STATION.

FIG. 1.—PORTO RICO STATION—RIVER BOTTOM LAND AND PART OF MAYAGUEZ, AS SEEN FROM THE STATION RESIDENCE.

FIG. 2.—PORTO RICO STATION—BOTTOM LAND, PRINCIPAL BUILDINGS, AND UPLAND BEYOND, AS SEEN FROM AÑASCO ROAD BRIDGE AT THE RIVER YAGUEZ.

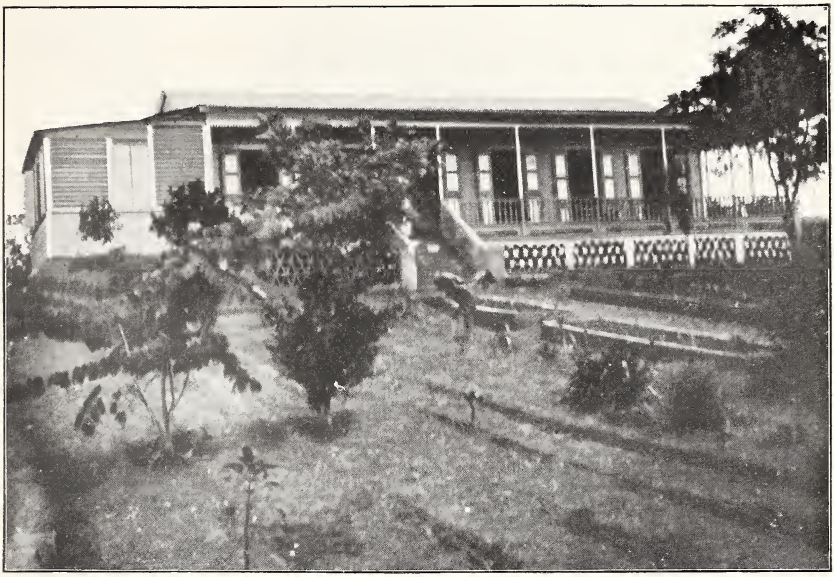


Fig. 1.—Porto Rico Station—Station Residence.

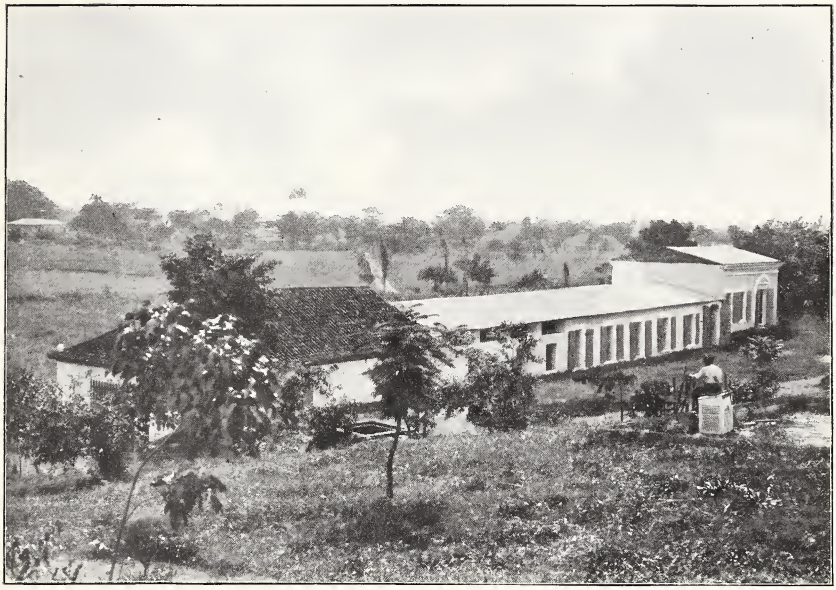


Fig. 2.—Porto Rico Station—Office, Laboratory, and Storage Quarters.

containing three kilns and several drying sheds, also numerous small huts for the use of the laborers on the farm.

To fully equip the station with suitable buildings and put the farm in the best condition for effective work, funds in addition to those granted by the National Government will be required, and it is therefore hoped that the insular government will continue its liberal policy toward the station.

EQUIPMENT.

A fair equipment has already been collected for the use of the station in the way of work animals, wagons, plows, harrows, and other machinery; also a good supply of small implements, such as shovels, forks, hoes, rakes, scythes, machetes, etc. A small amount of apparatus for spraying purposes and for the pruning of trees has been secured; also various chemicals and insecticides.

The office is provided with a fair amount of furniture in the way of desks, chairs, and bookcases, together with the smaller furniture which goes with them. A library has been commenced, and about 200 bound volumes are now on its shelves, with a considerably larger number of unbound publications. An exchange list has been organized with a number of leading agricultural periodicals, not only in the United States, but in foreign countries as well, and upward of twenty different periodicals are now on the files of the station. A collection of economic plants and insects has been commenced under the direction of the entomologist and botanist. With sufficient means at our command, it is only a matter of time when this equipment can be made a most valuable one to the people of Porto Rico.

The clearing of a portion of the land for the planting of crops has been commenced, and plants and seeds of different kinds are being secured, not only from different sources at home, but also from foreign countries and neighboring islands.

SOIL SURVEY.

The soil survey conducted in cooperation with the Bureau of Soils of the United States Department of Agriculture, which was spoken of in the first report, was commenced in January and completed in April of the present year. The Bureau of Soils furnished three experts during this time to carry on the field work, and also bore the larger part of the field and traveling expenses.

The area surveyed comprises a strip 10 miles in width, extending from the north shore at Arecibo in a north and south direction along the line of the military road to the south shore at Ponce. It embraces 360 square miles, or about 220,000 acres, which is equivalent to one-tenth of the island. In crossing the island it cuts all the principal geological formations, which extend for the most part in an easterly

and westerly direction, and it also extends into districts of maximum climatic differences. This survey, therefore, includes nearly all of the soil and climatic conditions to be found on the island.

On account of the very rugged character of much of the district, the lack of any topographic maps, and, in fact, the lack of a geographic map which was accurate, the work proved to be most difficult. All roads, trails, and streams had to be traversed and a base map made on which to map the soils. Much credit is due the field party for the satisfactory way in which the work was executed.

The work consisted in a classification of the soils of the area and mapping of each type on the scale of 1 mile to the inch; a study of the agricultural practices and possibilities, together with the best adaptation of each type to crops. Typical samples of soil and subsoil were taken from each type for physical and chemical study in the laboratory. The report and map resulting from this survey have been prepared and are ready for the press. They will first be printed as a part of the annual report of the Bureau of Soils. It is proposed to have a translation of the report printed in Spanish and issued at the same time by the station for distribution to the people on the island, together with an extra edition of the maps that may be secured from the Bureau of Soils. This promises to be of considerable economic importance, and it is hoped that the cooperative work can be continued year by year until the whole island has been surveyed.

COFFEE INVESTIGATIONS

For many years coffee has been the most important crop of the island. In acreage it far exceeds that of any other crop, and its export value has usually exceeded that of all other exports combined. The census of 1899 gave the acreage in coffee as 197,031. The damage caused by the hurricane of that year, together with the great increase in the world's supply of coffee and the fact that Spain, in giving up possession of the island, increased her tariff on Porto Rican coffee to about 8½ cents per pound, are conditions which have prevented any increase in the acreage of coffee. These adverse conditions make it all the more necessary that the experiment station should do what it can to support the chief agricultural industry of the island, and experiments with coffee are, therefore, taking a prominent place in the station work.

Seed coffee, which was gathered a year ago, has been planted in seed beds especially prepared for the purpose. This preparation consisted in plowing and pulverizing the soil, then elevating it into beds 3 by 15 feet in area, and surrounding each with planks to prevent caving. Straw-covered sheds were then constructed to protect the beds from direct sunlight and from heavy rains. (Pl. XXXII, fig. 4.) During the month of January, 1902, the seeds were planted in the beds, 2

FIG. 1.—PORTO RICO STATION—MAGUEY (FURCRÆA GIGANTEA) IN FLOWER.

FIG. 2.—PORTO RICO STATION—MAGUEY (FURCRÆA GIGANTEA).

FIG. 1.—PORTO RICO STATION—BANANAS, STATION GROUNDS AT RIO PIEDRAS.

FIG. 2.—PORTO RICO STATION—KAFIR CORN AND NATIVE CORN.

FIG. 3.—PORTO RICO STATION—EXPERIMENTAL TOMATO PLAT RESULTS OF A BACTERIAL DISEASE.

FIG. 4.—PORTO RICO STATION—COFFEE SEED BEDS.

inches apart each way, there being approximately 1,600 seeds in each bed, the total number of beds being 20. In from six to seven weeks the seeds germinated, and resulted, a few weeks later, in a good stand of healthy plants. Eighty additional beds, similar in every respect to those planted, also provided with straw roofs, were then constructed for nursery beds. When the small plants had fully developed their second pair of leaves they were transferred from the seed beds to the nursery beds in order to give them more room to develop. During this transferring process another selection was made by rejecting all inferior plants, or those having poorly developed root systems. In the nursery beds the plants were set 6 by 6 inches apart, there being 100 beds. Fertilizers of different kinds and different amounts were applied to these in order to accelerate the plant growth, as well as to ascertain the kind of fertilizer best suited to this purpose.

Arrangements have been made to carry on experiments with reference to the improvement of an old coffee grove on the estate known as "La Carmelita," situated about 8 miles north of Ponce, operated by the "La Carmelita" company. Ten acres have been divided into as many plats, from which the present crop is being harvested and the yield of each plat ascertained. After the crop has been gathered each plat will be treated in a different way, some being thinned and pruned, others having the plants cut off a few inches above the ground in order to obtain thereby a new growth. Some will be given cultivation, while others will have the shade reduced, etc.

Twenty-five acres of virgin forest land has also been arranged for, and a part of it will be cleared and planted with the new plants from the nursery. Different varieties of coffee are also being secured from different coffee-producing countries, in order to ascertain what varieties may be best suited to the conditions of Porto Rico, as well as to give an opportunity for cross-breeding, budding, etc., which will be important factors in coffee improvement.

TEMPORARY EXPERIMENTS AT RIO PIEDRAS.

The field experiments conducted at Rio Piedras, near the capital, were necessarily of a temporary nature, for the reason that it was desirable to secure a permanent site and have the station located, in order that experiments of a permanent character could be taken up at the earliest possible date. Arrangements were accordingly made for this purpose by the leasing of a building for office, laboratory, and living quarters, and also 30 acres of land, a part of which was cleared of weeds and brush, the drainage system improved, and the soil prepared for crops.

Planting began early in November and was continued at frequent intervals until June, 1902. The different plantings were made in order

to ascertain, if possible, the best season of the year in which to plant, or, in other cases, because the seeds for planting had not been previously secured. Some of the plantings were also made in order to test different kinds of commercial fertilizers, and others to experiment with different methods of cultivation. Repetitions in the plantings were necessary, because the plants were either destroyed by "changa" or the seeds were eaten up by ants or field mice.

The season was abnormal; November, December, and January were unusually wet, the total rainfall for the three months being 23.89 inches. During these three months there were only seventeen days on which no rain fell. At the close of January dry weather set in, and during the month of February the total rainfall was less than one-half inch, while for March it was only 2.19 inches. This very dry spell, with high trade winds from the east, lasted until the middle of April, when rains again set in, and during May and June the total rainfall was 21.53 inches.

The table below shows the various classes of crops planted and gives, in condensed form, the number of varieties of each, the number of plantings, and the character of the experiment, together with the results and a few miscellaneous notes. The fact that many of these products have proven failures does not mean that they can not be successfully grown on the island. The time has been too short and the conditions during that time too unfavorable to draw from them many definite conclusions. Many of the crops that have failed entirely might have succeeded fairly well if planted on better soil, subjected to more normal weather conditions, and left undisturbed by insects and diseases. The most important points brought out by these experiments were the impoverished condition of the soil and the necessity of meeting it with some rational system of manuring; the need of remedial measures for combating insect enemies and plant diseases, and the fact that tropical conditions are unfavorable to the growing of many of the northern truck crops.

Mention will here be made only of some of the more important crops or of those that have received most attention:

Summary of experiments with various crops at Rio Piedras.

VEGETABLE AND GARDEN CROPS.

Name of product.	Number of varieties tried.	Number of plantings made.	Character of experiment.	Result.	Miscellaneous notes.
Artichoke	1	1	Adaptation	Failure	Failed to sprout.
Arrowroot	1	1	do	Fair	Not matured.[a]
Asparagus	1	3	do	do	
Beans	9	9	do	Failure	Leaf hopper great enemy.
Beets	7	6	do	Fair	
Cabbage	3	3	do	do	
Canna, edible	1	1	do	Excellent	

[a]The tropical vegetables require a long time to come to maturity and these were not ready to gather when the station was removed from the Rio Piedras grounds.

Summary of experiments with various crops at Rio Piedras—Continued.

VEGETABLE AND GARDEN CROPS—Continued.

Name of product.	Number of varieties tried.	Number of plantings made.	Character of experiment.	Result.	Miscellaneous notes.
Cantaloupe	1	1	Adaptation	Failure	Eaten by changa.
Carrot	1	1	do	Fair	
Cauliflower	1	1	do	Failure	
Castor bean	1	1	do	Good	Not matured.[a]
Celery	1	1	do	Failure	
Corn, sweet	11	8	do	do	
Cucumber	6	8	do	do	
Dioscorea	2	2	do	Fair	
Eggplant	2	2	do	do	
Gumbo	3	3	do	do	Suffered from plant lice.
Ginger	1	3	do	do	
Hedionda	1	1	do	do	
Lettuce	5	6	do	do	
Luffa	1	1	do	Failure	Did not sprout.
Malanga	1	1	do	Poor	Soil too dry.
Muskmelon	5	6	do	Failure	
Onion	4	6	do	Fair	Some plantings failed.
Parsnips	2	3	do	do	
Parsley	2	3	do	do	
Peas	5	4	do	Poor	Matured too early.
Peanuts	1	2	do	do	Injured by mice and spot fungus.
Peppers	3	1	do	Failure	
Potatoes:					
Sweet	5	14	Fertilizers	Fair to excellent.	Yields 1 to 10 tons per acre.
Irish	1	3	Adaptation	Failure	Destroyed by root rot.
Radishes	6	5	do	Fair to good	
Sechium	1	1	do	Failure	
Spinach	2	3	do	do	
Squash	4	7	do	Fair	Mice ate seeds.
Tomatoes	3	4	Adaptation and disease.	Failure	Destroyed by bacterial disease.
Turnip	2	4	Adaptation	Poor to fair	
Watermelon	7	8	do	Fair	
Yam	1	1	do	do	
Yautia	6	8	do	do	Not matured.[a]
Yuca	4	8	do	Poor to good	Do.

FLOWERING BULBS.

Name of product.	Number of varieties tried.	Number of plantings made.	Character of experiment.	Result.	Miscellaneous notes.
Amaryllis	1	1	Comparison	Good	Common on island.
Freesia	1	2	Adaptation	Failure	
Hyacinths	1	1	do	Poor	
Lilies	3	22	do	Fair	
Narcissus	1	3	do	do	

FIELD AND FORAGE CROPS.

Name of product.	Number of varieties tried.	Number of plantings made.	Character of experiment.	Result.	Miscellaneous notes.
Barley	1	1	Adaptation	Failure	
Blue grass	1	2	do	Fair	
Clover:					
Alfalfa	1	2	do	do	
Alsike	1	1	do	Failure	
Common red	1	2	do	do	
Crimson	1	1	do	do	
Corn:					
Dent	1	2	do	Poor	
Native flint	1	1	do	Fair to good	
Kafir	1	2	do	do	
Cotton	1	2	do	Fair	
Cowpeas	6	3	do	Poor	Leaf hopper a great enemy.
Malojilla grass	1	1	Forage	Good	
Millet	1	1	Adaptation	Failure	
Oats	1	2	do	Poor	Forage, but no seed.
Peas, Canada field	1	1	do	Fair	
Rye	1	1	do	Failure	
Teosinte	1	1	do	Good	
Tobacco	1	1	do	Failure	Seed failed to sprout.

[a] The tropical vegetables require a long time to come to maturity and these were not ready to gather when the station was removed from the Rio Piedras grounds.

VEGETABLE AND GARDEN CROPS.

Beans.—Nine varieties were planted, as follows: Early Market, Wardwell Kidney Wax; Challenge Pole; Perennial Climbing; Stringless Green Pod; a Kansas variety, no name; Refugee; Improved Golden Wax, and Early Red Palestine.

The two varieties first named were planted November 23 and 27, respectively. They came up and grew well for a short time, but were destroyed by a fungus which attacked the base of the stem and part of the root system. The variety Challenge Pole was planted December 26, and in August, about eight months later, the vines had made a fair growth and were filled with blossoms. They had also matured a few pods and were not much bothered by insects. Perennial Climbing failed to germinate. The next two named varieties, planted in January and February, were destroyed by leaf hoppers, as were also the varieties Refugee and Improved Golden Wax, which were planted in May and June, respectively.

In May several of the above-named varieties were again planted, but the leaf hopper at this time was so prevalent that very few of the plants survived.

Beets.—Seven varieties were planted in six different plantings. Several of these plantings did fairly well, and beets of 2 or 3 inches in diameter were produced. Those that were planted later than May were usually attacked by a leaf roller, which frequently destroyed all of the foliage. One variety of sugar beets was tried and proved a failure.

Cabbage.—Three varieties were tried in three different plantings. In the first two the seeds were placed directly in the beds in the field and were a failure. The third trial, however, was made with the seeds in a box under shelter, and a good supply of healthy plants was secured. These were transferred to the field, and approximately one-fourth of an acre was set with them. Most of them lived, but made very slow growth and were badly infested by a cabbage worm which perforated the leaves almost as fast as they were formed.

Sweet corn.—Eleven different varieties were tried in eight different plantings, a planting usually being made about every month. Although in some instances the corn was taken from the ground by mice or eaten by ants (which are very fond of anything sweet) before it had time to germinate, we usually succeeded, by replanting and trapping the mice, to get a good stand, and for a very short period the corn usually grew very well. It was very badly infested by a budworm which ate the centers out of the stalks, so that they rarely attained a height of more than 2 or 3 feet. Occasionally a stalk would tassel and form silk, but of all these plantings no ear of corn ever reached the roasting-ear stage.

Cucumbers.—Six different varieties were tried in eight different plantings. These plantings extended from November, 1901, to May, 1902, and in the majority of cases proved to be failures. The young plants were unable to withstand the attacks of a small beetle and a mite, as well as the fungus diseases which prey upon them. A few plants succeeded in reaching a mature age, blossomed quite freely, and bore a number of fruits, some of which attained a size of 6 to 8 inches in length.

Lettuce.—Five different varieties were tried in six different plantings, and as a rule the plants made a fair growth. They were sometimes destroyed by the changa, but no other insect or plant disease seemed to affect the plants. The growth of the lettuce, however, was usually too slow to produce a tender product, and it almost invariably had a bitter taste.

Peas.—Five different varieties of peas were tested in four different plantings. They always came up nicely and grew rapidly for a very short time, when the growth seemed to be suddenly checked. The plants would blossom very early, were very small, and produced a few pods, usually with from 1 to 3 peas in a pod. In some instances the plants would be entirely matured within five weeks from the time the seed was planted.

Sweet Potatoes.—Five different varieties of sweet potatoes were tried, and as a rule they did fairly well. There were a number of plantings made on which fertilizers were tried, and of which report will be made under the head of "Fertilizers."

Irish potatoes.—These were tried at three different times and each time proved an absolute failure on account of bacterial disease which destroyed the entire plant, usually before the period of blossoming.

Radishes.—Six varieties of radishes were tried in five different plantings. Many of them were destroyed by the changa, but a fair stand was usually secured. Without the use of fertilizers they grew very slowly and were tough, but where given a liberal supply of commercial fertilizer they made a good growth and were quite tender, although rather strong to the taste.

Squashes.—Four different varieties were tried in seven different plantings. Of all the cucurbitaceous plants the squash seemed to do best, and where the soil was sufficiently fertile the vines usually made a fair growth and produced fruits of a fair size, which ripened and were of fair quality.

Tomatoes.—Three varieties of tomatoes were tried in four different plantings. It was not at all difficult to produce fine plants which grew well for a short time after being transferred to the field, but in each instance they were attacked by a bacterial disease, or a blight, which swept away the entire field before fruits matured. Pl. XXXII, fig. 3, shows the appearance of the experimental plat just before the

last plants had died, and Pl. XXXIII, fig. 4, shows a portion of a large tomato field about a mile distant, which was affected in the same way. The field last referred to contained 30 acres, all of which was planted to tomatoes. A few crates of very good tomatoes were produced from this field, but I am told that the loss on this enterprise was approximately $5,000. In the case of the experimental field, every effort was made to check the progress of the disease by the application of a Bordeaux mixture, but this seemed to be of no avail, for plants that were sprayed repeatedly every few days seemed to perish as rapidly as those which were untreated. On several occasions specimens of the leaves and stems of the affected plants were collected and sent to the pathologist of the Department in Washington for a careful study of the disease. The results of this investigation have not yet been learned.

Watermelons.—Seven different varieties were tested in eight different plantings. During the early stages of growth the plants were more or less affected by insects and fungi, but a fair percentage of the plants succeeded in growing. The vines made a considerable growth, blossomed, and produced watermelons, many of which were of good size and good flavor. One of the worst enemies, however, was the field rat, which usually succeeded in eating a hole in the melon just before it would ripen, in order to get the seeds.

The tropical vegetables have usually succeeded much better than those from the North and have been more exempt from the attacks of insects and less affected by disease. Most of them require a longer period for maturity, and therefore such as yuca, yautia, malanga, arrowroot, and others were not reported upon, because they had not matured when the grounds at Rio Piedras were abandoned.

Several inquiries have been received as regards the possibilities of growing yuca or cassava for the manufacture of starch, and while the station has thus far no definite data, it may be said that the climatic conditions are favorable, and on sandy soil, with good seed and proper management, the indications are favorable. The experimental plats were badly infested by a bud worm for a time, but the plants recovered from the attack and grew well. Pl. XXXIII, fig. 2, shows a plat eight months after planting.

FIELD AND FORAGE CROPS.

Blue grass was tried at two different times. The first time an ordinary amount of seed was sown, with the result that so few plants were secured that it was practically a failure. In the second trial a very large amount of seed was used on a small area and a perfect stand of grass was secured. During the dry season in February this was watered at frequent intervals in order to keep it growing, and it continued to grow and made a fair stand, although at the time of leaving

FIG. 1.—PORTO RICO STATION—YAUTIA, OR TARO.

FIG. 3.—PORTO RICO STATION—BERMUDA LILIES.

FIG. 2.—PORTO RICO STATION—YUCA, OR CASSAVA.

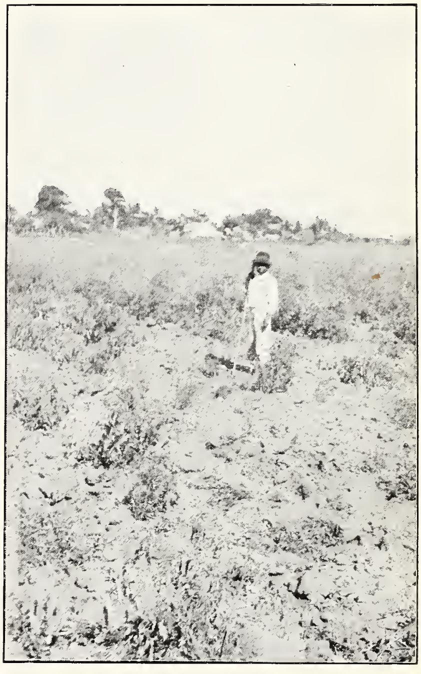


FIG. 4.—PORTO RICO STATION—DISEASED PART OF 30-ACRE TOMATO FIELD.

Rio Piedras, in September, none of it had yet produced seed. It is a question if it will continue to grow year after year. If it does it will be very important in relation to the production of lawns, as none of the native grasses seem to be well suited to this purpose, and there are practically no lawns to be found anywhere on the island.

Clover.—Alfalfa, alsike, common red, and crimson clovers were tried. All these perished after a few months excepting the alfalfa, which was still living at the time the ground was abandoned in September. Its growth, however, had been rather slow, which might naturally be expected on account of the poor character of the soil. On better soil, and especially in the interior, where the lands are better drained, the indications are that alfalfa may succeed, and if it does it will be an important crop, not only for forage, but also for building up many of the worn-out lands and for holding the soil in place on steep hillsides.

Corn.—Dent corn was tried twice, but did very poorly. It seems to be troubled in much the same way as the sweet corn—by a bud worm which eats out the center of the stalk. Even when not interfered with by the worm the growth is usually slow and the plants tassel prematurely. The native corn, which is a flint variety, did much better, and under the most favorable conditions produced a good yield of merchantable corn. Kafir corn also succeeded quite well and produced an abundance of seed. The stalk, when cut down close to the ground, sent up a second growth of suckers which also produced a crop of seed fully as good as the first. How long this suckering process might continue is a matter for experiment. Pl. XXXII, figs. 1 and 2, shows Kafir corn and native corn when in flower.

Cotton.—This product was planted at two different times, and though the plants were small they produced an abundance of cotton. A certain company which has large interests in the United States has planted cotton every month in the year at a number of places on the island, and its agent informs me that they are convinced that cotton can be very successfully grown. On the basis of their results a company has been formed and arrangements are being made to plant a considerable area of this product. If they succeed it is their purpose to install the necessary machinery for ginning the product.

Oats.—Oats were tried twice and came up very well, and usually produced a fair amount of forage. There were only a few spears, however, that ever produced seed, and these were of a very chaffy character.

Teosinte.—This is a large, rank-growing grass which grows very rapidly and matures seed in about three months. When cut down to the ground it readily grows up again and promises to be a very useful grass for forage.

As will be seen from the table relating to field and forage crops, a number of other kinds were tried, but many of them proved to be failures, and it is doubtful if such as barley, rye, millet, or oats would

succeed anywhere on the island, because they are too far removed from their native habitat. In some instances the failures that are recorded in the table are due to the fact that the seed failed to germinate. This, of course, would not be a true test for the product in question.

FLOWERING BULBS.

Several crates of flowering bulbs were sent to the station by a prominent grower in New Jersey. These consisted largely of Bermuda lilies, together with a small amount of freesia, hyacinths, and narcissus. The lilies were planted on several parts of the experiment station grounds, also on some very sandy soil of the American Fruit Company, in order to test the effect of the different types of soil upon them. Owing to the considerable time that the bulbs remained in the crates before they were received and opportunity was given to plant them, they were in poor condition, and as a result many of them did not grow. Fairly good stand was secured, however, but the plants made a small growth and blossomed much earlier than was expected. The flowers were of good size and very beautiful, there usually being two produced on each stalk. Pl. XXXIII, fig. 3, shows the photographs of a number of these beds just before the close of the flowering period. Had this been taken somewhat earlier it would have shown a much greater number of blossoms.

The amaryllis was from a single bulb which was purchased at a seed house in the States and cost 15 cents. It was found, however, that it is identical with a flower which grows in great abundance throughout the island as a wild plant. Could the bulbs of these wild plants be dug up and sent to the States and sold at this rate it would prove a profitable enterprise.

INSECT ENEMIES.

Insect enemies have been very troublesome and in many instances have been almost wholly responsible for the failure of crops. Vegetables from northern-grown seeds have more frequently yielded to the depredations of insects than have the native ones, but this may be due to the fact that the former are usually not well adapted to the climatic conditions and in their weakened state show the effect of insect attacks more plainly.

Among the more common insects may be mentioned the leaf hopper, which has been very bad on cowpeas and all forms of garden beans. It is a small bug that infests the leaves and sucks their sap. When the plants are disturbed it hops to the ground or to other plants. In the daytime it usually remains on the underside of the leaves and is most numerous on the younger plants. It is therefore difficult to treat with a spray, and being a sap sucker it is impossible to poison it. It was treated to slug shot, whale-oil soap, and kerosene emulsion, and by frequent applications many were destroyed, but there always

remained sufficient of them to continue damaging the beans. Another pest which was noticeable on the cowpeas was a caterpillar which ate the pods.

The May beetle was bad at seasons and the adults ate the leaves of quite a variety of crops, while the larva attacked the roots of many kinds of plants. Bud worms and cabbage worms were very numerous, especially on yucca and cabbage. A leaf roller was particularly destructive to beets and in some cases completely defoliated the beet plats in a few days.

Plant lice were plentiful and preyed upon quite a range of plants. The ants which foster them are always present in overwhelming numbers.

THE CHANGA.

Among the insects of Porto Rico no other is to be compared to the changa, or mole cricket, for general destructiveness or for the wide range of plants that it attacks. So bad were the ravages of this insect that it was early decided to make it a subject of special study. The station entomologist, O. W. Barrett, has given much time to the study of its habits and to trying all sorts of remedial measures for exterminating it. Time enough has not yet elapsed to have completed the study of its life history; neither have the remedies thus far tried been so satisfactory as to warrant discontinuing further investigation with reference to it. Much valuable economic material has been gathered, and in view of the demand for this kind of information by the Porto Rican planters a bulletin in both English and Spanish has been issued, entitled The Changa, or Mole Cricket, in Porto Rico. A cut (fig. 1) of the changa and extracts from the bulletin are here presented:

Since the hurricane of 1876 the mole cricket (*Scapteriscus didactylus*) or "changa," as it is popularly called, has continued to be by far the most serious insect pest that the Porto Rican agriculturist has had to deal with. Its damages to tobacco, cane, and small crops in the island amount to probably more than $100,000 annually. Its habits are well understood by the planters, but there seems as yet to be no definite method of combating it successfully, and an authority states that "nothing appears to be known of its economic status."

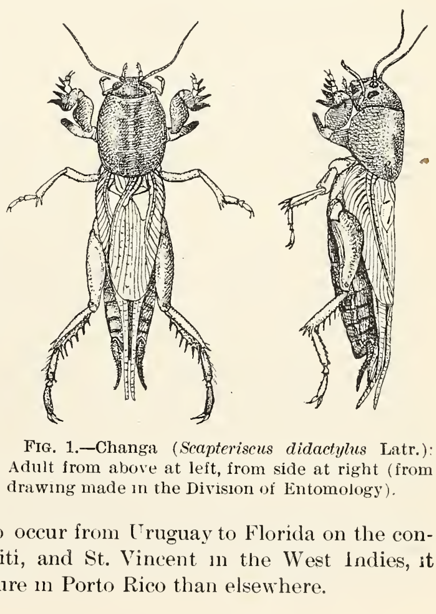


Fig. 1.—Changa (*Scapteriscus didactylus* Latr.): Adult from above at left, from side at right (from drawing made in the Division of Entomology).

Though the species of mole cricket common in Porto Rico has been known for many years, it seems that Brunner and Redtenbacher were the first to report it (1892) as inhabiting this island; and although it is known to occur from Uruguay to Florida on the continent, and also in Cuba, Jamaica, Haiti, and St. Vincent in the West Indies, it appears to be more injurious to agriculture in Porto Rico than elsewhere.

DESCRIPTION.

The changa is an insect found throughout the island, living in galleries in the ground. It is about $1\frac{1}{4}$ inches long in its adult stage; its color is a light brownish fawn, more or less mottled with darker areas above and a uniform brown beneath. Its shape is approximately cylindrical and proportionately longer than that of the true cricket. * * *

The expression of the face has a fancied resemblance to that of a monkey, whence the name "changa," being the popular name in Spanish for a pet monkey. * * *

The first pair of legs are good examples of specialized structure; all the parts are greatly modified and peculiarly adapted to the excavation of burrows or tunnels in the earth. * * * When closely bent, the whole leg has a somewhat elliptical outline and is a model of strength, compactness, and adaptability to purpose. Indeed, with the 4 picks and 10 shovels of its first pair of legs, it is no wonder that the changa can burrow its own length in ordinary soil in the space of half a minute. The second and third pairs of legs are of medium size; they present several short but strong spines, and their feet have three joints each, with a pair of claws which are independently movable. Although not structurally fitted for jumping, the three pairs of legs acting in unison suffice to enable the changa to make clumsy leaps of several times its own length. * * *

The entire surface of the body is covered with a short, sparse, yellowish down, though in adult specimens the head, legs, and wing covers are nearly naked. These minute hairs serve to prevent the surface of the body from becoming wetted by contact with the very wet soil through which the changa sometimes has to burrow; they also, by holding the air, enable the changa to float readily upon the surface of water, and this fact enables it, when washed out of the surface soil into a stream or pool, to escape drowning.

LIFE HISTORY.

As above stated, time enough has not yet elapsed for a study of the changa's complete life history. The eggs are deposited in the enlarged end of a side gallery to the changa's burrow from a few inches to a foot or more beneath the surface of the ground. Each female lays from 50 to 100 eggs, which hatch in about two weeks. The larva or young changa is at first nearly white, but soon takes on a darker color and also a clothing of short hairs. It is very active and can readily jump twenty-five times its own length. It grows slowly and probably requires a year or more to come to maturity.

GENERAL HABITS.

The young changa very seldom leaves the ground unless driven out by water, but the adults are frequently to be seen hurrying over the surface even in the daytime. Their gait is more clumsy and irregular than is the case with most crickets. When greatly excited, they supplement their ordinary gait with short jumps.

The adult males frequently fly at night and are attracted to light. Though their flight is laborious, like that of a large beetle, and not long sustained, they sometimes rise to a light 20 feet or more above the ground. They seem to prefer dark, cloudy nights in which to make their aerial excursions. There are doubtless other conditions which are important regarding the flight of the changa, because of two apparently similar evenings the changa may emerge in great numbers in one, whereas during the other scarcely a single one may be seen. From 7 o'clock until 10 o'clock are the hours preferred for their flights. Thus it does not, as has been stated, fly only at twilight.

The changa is sensitive to humidity. Unless the surface of the soil is moist, it remains at a depth of several inches, and if the soil is saturated it comes to the surface and escapes or remains hidden in grass clumps. Whenever the soil is moist and not too hot, be it night or day, its work of destruction is carried on, though, of course, much the greater amount of damage is done at night. Its habit of burrowing just beneath the surface in a great measure saves it from the attacks of lizards, but not entirely from fowls and blackbirds, that are quick to notice the slightest movement of the earth on top of the burrow and to recognize the cause thereof. These burrows may be traced often for several feet, or even yards, the loosened and raised convex surface plainly indicating the course taken. and at the end of the visible portion of the burrow there may be noted an opening, either the entrance or exit, or else the descent of the burrow. These burrows, ramifying through the soil in the vicinity of food plants, are kept open and utilized for a considerable length of time by all the mole crickets frequenting that soil area. Thus it will be seen a changa can readily pass from the roots of one food plant to those several feet, or perhaps even yards, distant without emerging from the ground or making any new gallery. This fact partially accounts for the great number of small seedling plants which may be destroyed by one or two crickets in a plat of ground in the space of one night. Keeping the earth pressed firmly about the roots of a plant closes the burrows and greatly hinders the changa's operations.

FOOD HABITS.

The changa's food consists almost wholly of living plants. The stomach, however, is always found to contain more or less mud and sand, which is probably unavoidably eaten along with the roots. Portions of decaying plants and the leaves and stems of living plants are sometimes eaten. When food is scarce the leaves and roots of plants, especially those of the "yerba dulce," are drawn into the galleries, sometimes to a distance of a foot or more, there to be consumed at leisure during the daytime. * * *

The usual point of attack on a plant is the crown or junction of stem and roots, but the whole root system and a good part of the stem is frequently devoured. In eating the stem the changa often remains just beneath the surface and pulls down the plant as fast as it is consumed. Thus a plant 4 inches in height in the evening may appear only 1 or 2 inches high the next morning.

Plants having a poisonous or acrid sap are free from attacks. The economic plants most injured by the changa are cane, tobacco, and rice. Among the small crops the tomato, eggplant, turnip, and cabbage are most affected. Very little is known as to the extent of the damage upon the coffee crop; but a considerable percentage of the young seedlings in the nursery beds belonging to the experiment station have been deprived of their taproots. Young seedlings of citrus fruits are frequently attacked, but much of the loss usually attributed to the changa is due to the grubs of the orange-leaf weevil (*Exophthalmus spengleri*), or to those of the smaller May beetle (*Lachnosterna* sp.), or to a peculiar bacterial or fungus disease known locally as "san cocho," which causes the bark of the roots and stems near the soil surface to decay.

Of ornamental plants the coleus seems to be a favorite food. The castor-bean plant, watermelon, bean, sweet potato, cassava, and "yautia" (taro) are seldom or never attacked.

It seems that in its habits of gnawing away a ring of bark from roots and underground parts of stems of some plants and of eating directly into the heart of others the changa shows a sort of mania for killing quite beyond its hunger-satisfying instinct. * * *

INTRODUCTION INTO PORTO RICO.

It is the current belief among the better-informed agriculturists here that the changa first reached Porto Rico in a shipload of guano brought from South America about the year 1850, but since the same species is found throughout tropical America from Uruguay to Florida, it seems probable that the changa was here before the

guano arrived. However, it was not universally considered a serious pest until after the hurricane of 1876, which practically destroyed its worst enemy, the blackbird. For the next few years the changa was so abundant in some localities that they often came to the lights in the houses in such numbers as to literally cover the floors with a loathsome, wriggling mass of their bodies. Since about 1885 their numbers were slightly diminishing until the hurricane of August 8, 1899. It is said by some that they first appeared in the west end of the island and have gradually migrated eastward.

The vicinity of Mayaguez was the first district of the island to suffer from this plague, and it happens that the estate recently purchased by the insular government for the permanent use of the experiment station at Mayaguez, which was formerly known as "La Carmen," was the first estate to abandon the cultivation of cane on account of the ravages of the changa and the cane disease which was believed to always follow the changa's attacks.

CLASSIFICATION.

The following statements regarding classification and distribution, prepared by Mr. Barrett, were omitted from Bulletin No. 2 on account of its technical nature:

The changa belongs to the order Orthoptera, which includes some 30,000 or more species comprised under the heads of cockroaches (Blattidæ), walkingsticks and leaf insects (Phasmidæ), mantids (Mantidæ), crickets (Gryllidæ), grasshoppers (Acridiidæ), and the locusts (Locustidæ). The earwigs (Euplexoptera) were formerly included in this order.

The first Gryllidæ includes the mole cricket (Gryllotalpinæ), the field cricket (Gryllinæ), the tree cricket (Œcanthinæ), and two or three but little known families. The subfamily Gryllotalpinæ includes the true mole crickets (Gryllotalpinæ), and the water mole crickets (Tridactylini). The latter tribe includes the genus Tridactylus—small insects to be observed hopping over stones or sand near water courses; they seldom exceed half an inch in length and resemble a young changa, but have two pairs of stylets at the tip of the abdomen. A species of this genus was sometimes, though rarely, seen at the station grounds at Rio Piedras.

The black mole crickets (Stenopelmatinæ) are wingless, heavy-bodied locusts living under stones and logs; none have been found, to our knowledge, on the island. The black mole cricket of Mexico (*Stenopelmatus talpa*) is usually parasitized by a larval form of hair snake (*Gordius* sp.?); and this parasite serves to keep the species in check in that country.

The tribe Gryllotalalpini comprises some thirty or more species of the genera Gryllotalpa and Scapteriscus, all of which have similar habits and are similar in appearance; the principal differences are in the size, coloring, and hairiness or spininess. They all make subterranean galleries; some remain during the day in more or less permanent retreats beneath stones, issuing at night to forage.

The shrill stridulation which is heard here during every night in the year is produced for the most part by two species of tree crickets, a small species of locust (*Xyphidium fasciatum* De Geer), and the common cricket (*Gryllodes mutucus* De Geer) which sometimes enters houses. The changa's faint note can also be distinguished among these noises when once the ear becomes accustomed to it as a unit.

DISTRIBUTION.

Though found in all the continents, the species of mole crickets are most numerous in tropical America; 15 species are recorded from this district. Five species inhabit the East Indian region and at least 4 are known from the West Indies. Six species are known in the United States, 4 species of which have become established in Florida.

The following is a list of the most important species and their habitats:

Species.	Region inhabited.
Gryllotalpa gryllotalpa L	Europe, W. Asia, N. Africa, Java (?), Isle of Bourbon.
G. unispina Sauss	Turkestan.
G. longipennis De H	Java, Borneo.
G. minuta Burm	Cape of Good Hope.
G. africana Beau	Africa (except north coast), Madagascar, S. Asia, East Indies, Japan.
G. debilis Gerst	Zanzibar.
G. hirsuta Burm	Singapore, Sundas.
G. coarctata Walk	Ceram, Australia.
G. australis Frichs	Ceram(?), New Caledonia, Australia.
G. siamensis Giebel	Farther India.
G. nitidula Serv	Australia.
G. devia Sauss	Cape of Good Hope.
G. chilensis Sauss	Chile.
G. claraziana Sauss	Argentina.
G. hexadactyla Perty	Brazil, Peru, Colombia, Guianas, Costa Rica, Grenada, Mexico, Cuba, St. Vincent, Guadalupe.
G. macilenta Sauss	Surinam.
G. intermedia Sauss	Gulf coast region of Central America and Mexico.
G. cultriger Uhler	El Paso, Tex., to California, U. S. A.
G. major Sauss	Illinois and Kansas, U. S. A.
G. borealis Burm	U. S. A. and Canada east of Rocky Mountains, Mexico(?), Cuba.
Scapteriscus tenuis Scud	Brazil.
S. oxdactylus Perty	Brazil.
S. mexicanus Burm	Brazil, Colombia, Mexico, Florida (U. S. A.)
S. didactylus Latr	Uruguay, S. A., to Florida, U. S. A.; also Cuba, Jamaica, Porto Rico, Haiti, and St. Vincent.
S. vicinus Scud	South and Central Africa.
S. agassizii Scud	Brazil, Central America, Santa Cruz.
S. variegatus Burm	Colombia, Santa Lucia.
S. abbreviatus Scud	Pernambuco (Brazil), Florida, U. S. A.

Besides the two species in the above list which are known to inhabit Porto Rico, it is obvious that *S. agassizii* of Santa Cruz, *S. variegatus* of Santa Lucia, and the two other species of Florida may be expected to appear here at any time; likewise *Gryllotalpa borealis*, *G. cultriger*, and *G. hexadactyla* are liable to be introduced in importations of nursery stock.

It may be interesting to note that a species of mole cricket, said to be the same as the Porto Rican changa, appeared in such numbers in Venezuela several years ago that the cultivation of cane had to be abandoned. We understand, too, that some districts of Africa and Australia are badly infested with the mole cricket. Several districts in Florida have had to be abandoned on account of this pest. And even in Canada the northern mole cricket has been found at the rate of 3,500 per acre in a cabbage patch.[a]

RELATION TO SOIL CONDITIONS.

The mountain districts of the interior are usually more free from the changa than the coast region. This is very largely due to the fact that the mountain soils are clayey, while those of the coast plains and the broad valleys are of an alluvial sandy loam. It is obvious that the changa can not work in clay, on account of its tenacious and noncompressible nature; while in the loose granular structure of the loamy soil the changa readily presses aside the particles of earth and forms a gallery, without excavating or bringing to the surface any of the displaced material.

As previously stated, saturation or overdryness of the soil are conditions avoided by the changa. Prolonged rains in lowlands are probably destructive to many of the young, which have come to the surface to escape drowning; and during a prolonged drought they descend to a considerable depth, and it is possible that in an open field some of the young die from their inability to find food or to migrate, as do the adults, by an overland trip.

We find that the changa evinces an aversion to making a surface burrow up the side of a plant hill or ridge of earth. For this reason single plants should be "hilled up" when practicable.

In sandy cane lands two and sometimes three plantings of the cane are necessary on account of the greater numbers as well as greater destructiveness of the insect in these soils; whereas in a cane soil that carries a high percentage of clay, as in those in the vicinity of Rio Piedras, only about 1 per cent of cane cuttings is destroyed by the changa. These rules hold good also for tobacco, rice, and other crops; the more clayey the soil the less damage can be done by the changa to crops grown therein. There is a difference of opinion among cane planters here as to the method of setting the cane cutting in the soil. Some aver that the cutting has a better chance when planted horizontally, because of the number of roots produced at all the nodes, while others claim that a changa will remain near a cutting until all the tender roots are devoured anyway, and therefore the upright position is better, which gives the continually forming roots a chance to grow and harden beyond the changa-food stage between the brief visits of the changa. But we believe the best plan to avoid the attacks is to lay the cane cutting, with its leaves still attached, upon the soil in a slight depression. Thus, as the young roots start they are touched by the influence of the air and the light, and when they are covered with the hoe, lightly at first and more deeply later, they are too hard for the changa's jaws.

Though our personal observations have not yet extended over an entire year, there is little doubt that the changa's period of greatest activity, as evinced by their com-

[a] James Fletcher, in 22d Ann. Rpt. Ent. Soc. of Ontario, p. 89.

ing to light and by their depredations in fields, is at the end of the rainy season, that is, in October, November, and December.

REMEDIES.

Generally speaking, preventive measures seem more advisable for small crops or limited areas than destructive remedies, with one exception, viz, the use of trap lights.

We may group the prophylactic remedies into two classes—the physical, or those which prevent the attacks of the changa by obstructions, and chemical, or those which prevent the attacks by the use of chemical substances having a repellant odor.

The most common means of preventing the destruction of small plants is by wrapping them in the leaves of the mamey (*Mammea americana*). This method is very common among the tobacco growers of the island. At the time of transplanting, the young plant, with a small quantity of earth, is wrapped in one or two mamey leaves laid lengthwise around the ball of earth; when placed in the soil the leaf forms an impassable barrier, although there is some danger that the changa may hop over the top ring of leaves, or enter at the bottom and thus gain access to the plant itself. We find, however, from our experiments at the station, that the wrapping of the young plant in this manner retards the growth of its root system, and probably in a measure suffocates the roots by preventing the free circulation of air and water in the soil about them. The thickness and gummy sap of the leaf prevents its decay in the soil for from two to six weeks. If carefully placed, however, the leaf or leaves may be drawn from the soil after the plant has attained sufficient size and vitality to enable it to resist the changa's attacks. Sections of banana leaves are also used like those of the mamey. * * *

An improvement upon the mamey-leaf wrapper is the wire-gauze "sleeve." Galvanized-iron wire cloth, having meshes too small to admit the passage of a half-grown changa, is cut into pieces about 6 by 10 inches. These pieces are rolled into cylinders, into which the young plants are set at the time of transplanting. These cylinders have the advantage of lasting for several seasons, of allowing the roots to extend outside the cylinder, and of allowing a thorough ventilation of the soil. These sleeves may be made of various dimensions to suit the kind and size of plant to be protected. It is always necessary to see that the vertical edges overlap a little, so that an entrance can not be forced between them; and it is well to allow the top rim of the cylinder to protrude 1 or 2 inches above the surface of the soil. Their diameter should never be less than 3 inches, except for very small plants, but the length may be 6 to 12 or more inches.

Cheesecloth has been tried as a barrier, but it rots so quickly that the changa soon passes through it. Cheesecloth covers for seed beds have proven effective in keeping the changas out. Mulches of tobacco stems and castor-oil pomace just beneath the surface of the soil have been tried, but are ineffective. Barriers of coal tar are likewise of no avail.

Clean cultivation may be called a physical remedy. The removal of weeds and grass from a cultivated crop necessarily removes a portion of the changa's food plants, and although at first thorough cultivation seems to indirectly incite the changa to even more ferocious depredations, we have found that the adults emigrate from a clean-cultivated field. It is obvious, of course, that the wingless specimens must remain, or else make an overland trip, which is strongly contrary to their instinct. Many of our first experimental plats were completely devastated during the first three or four months of our occupation of the grounds at Rio Piedras, but by keeping down the "yerba dulce" and all the other native food plants of the changa their numbers have rapidly decreased, until at present the only damages are those perpetrated by occasional tramp-like specimens. Moreover, keeping the ground clean around and between the cultivated plants affords a much better opportunity to the insectiverous birds for detecting the changa, so much so that in a clean-

cultivated, open field which is well policed by birds it is almost sure death for a changa to appear above ground, or even to disturb the surface soil in its tunneling operations during the daytime.

Whenever practicable a field should be plowed and kept free from weeds for several weeks prior to planting. This plan not only starves out the pests, but gives the birds a chance to destroy them.

Special search with hoe or spade in badly infested grounds, just after a heavy rain, may sometimes be relied upon to rid a plat of ground of changas. In this way the pests may be kept in control in small areas at a slight expense. * * * The subject of trap lights has attracted considerable attention, especially within the last two or three years, but for some reason their use has never become universal. * * * Our experiments show that the best and cheapest form of trap light is a lantern (the larger the better) suspended above a receptacle partially filled with water to which a little kerosene has been added. The changa is drawn to the light and, striking the chimney of the lantern or lamp, falls into the receptacle beneath. The water in this receptacle gives it stability and the layer of kerosene on top quickly kills the changas by stopping their breathing pores. The cost of running a trap like this is from 1 to 5 cents a night, depending, of course, upon the size of the wick used. * * * Lights placed at the sides of a field should be provided with reflectors to throw all the light into the field. Fortunately there seems to be very few species of beneficial insects caught in the traps here; on the contrary, adults of two species of cutworms, two or three species of the very injurious May beetles (*Lachnosterna* spp.), and the very numerous leaf-hoppers which infest plants of the bean family are caught in considerable numbers in the traps. A chimneyless trap light has proved almost utterly valueless as a changa killer; the flame is smoky, and even a light breeze causes the tin sides to become coated with a deposit of soot, which, of course, destroys their reflecting power.

Among the repellent remedies which have been tried at the station, mention may be made of naphthalin, carbon bisulphid, or "fuma," creosote, creolin, kerosene, and lime. Of these naphthalin has proven the most effective. The flake or white crystalline form, costing 5 or 6 cents a pound, was used in various ways and amounts, and had very little or no deleterious effect on plants. One-half to 1 dram placed in holes 1 to 1½ inches deep and 1 foot apart prevented the passage of the changa. It was necessary to renew the treatment every three to five days in order to keep the ground saturated with the vapor. Carbon bisulphid was more expensive and less effective than the naphthalin. Kerosene repelled the changa so long as the soil retained strong traces of it, but was found injurious to the plants. Creosote, creolin, and lime had practically no repellent action.

Arsenic in its various compounds is found to be the best substance for combating the changa plague; but its use is attended with some difficulties. The best method of applying it seems to be the following: A quantity of "yerba dulce" plants are gathered, and shaken free of dirt, and cut into pieces of an inch or less in length; then white arsenic or Paris green is sprinkled over the chopped pieces of grass, and the whole thoroughly mixed together so that each piece of the grass will contain more or less of the arsenic. This poisoned bait is then put upon or just beneath the surface of the soil in badly infested areas. The changa will come to this bait even when wilted. It is well to lightly cover this poisoned bait, so that fowls will not eat it. A good proportion is one-half ounce of Paris green (or white arsenic) to every quart (liter) of the chopped grass, though of course this formula may be varied considerably. It is well to moisten the grass before sprinkling on the poison, and we believe there is a slight advantage in adding sugar to the water used in wetting the grass. Instead of putting a large quantity of the bait in one place, it is more economical to strew it in lines or narrow rows among the plants near areas where surface burrows are numerous. Death ensues within a very few hours after eating the bait. Since most of the poisoned insects retire to their deepest retreats when

suffering from the effects of the poison and die there, the bodies are not readily found by the ants; but if a specimen chances to die near the surface, a procession of ants will mark the spot within a few hours. Thus the result of this remedy is not readily seen and its efficiency may therefore be doubted by the hasty observer. But the continued use of the remedy can not fail to keep in check, if not fully exterminate, the enemy in the treated area. Pure Paris green is better for the above treatment than the white arsenic, but at present it is not procurable on the island. It can usually be purchased from dealers in agricultural implements for about 20 or 25 cents per pound. The common arsenic, the powdered form of arsenious trioxid, can be purchased at any local drug store, although a physician's permit may be required. Even allowing for a very liberal waste, 5 ounces of arsenic, when used with "yerba dulce," or a similar bait, properly applied and distributed, should be sufficient to kill practically all the changas in 1 acre of ground within one week.

We find that cuttings of coleus stems 3 or 4 inches in length dipped in white arsenic powder and laid upon the surface of the soil is another remedy for the same trouble.

NATURAL ENEMIES.

Unfortunately the changa has few natural enemies in Porto Rico. Its habits of emerging at night, of spending nearly all its time well hidden beneath the surface of the ground, its comparatively large size, and its great strength, activity, and fecundity combine to render it peculiarly exempt from the dangers which beset the lives of most insects. There is a singular lack of ground beetles of the family Carabidæ here. With a greater abundance of these predaceous enemies of plant-eating insects, the early stages of the changa would be passed in less security. The parasitic flies (Tachinidæ) which trouble the lives of many species of insects can obviously never affect the changa. The hair snake (*Gordius aquaticus*) in its third (?) larval stage lives in the abdominal cavity of various species of grasshoppers in the United States, devouring the fatty tissues and finally the viscera. A very large percentage of the black mole crickets (*Stenopelmatus talpa*) of Mexico are similarly eaten piecemeal. But although we have examined hundreds of specimens of both sexes of the changa, we have never found the slightest trace of any internal or external parasites. Moreover, no trace of any fungus disease has been detected on the changa. In the near future we hope to experiment with the fungus which attacks grasshoppers in the Central States. This fungus (*Empusa grylli*) has been successfully used to inoculate individuals, which are then turned loose in the fields, where they carry contagion and death to the noninfected individuals. It is extremely doubtful, however, if this fungus can be inoculated into the changa, on account of the widely different habits of the grasshopper and the mole cricket, as well as the different climatic conditions here.

The red mite (*Trombidium locustarum*), which is so common a parasite on grasshoppers in the United States, does not attack our changa.

Probably the most important natural enemy of the changa is a species of blackbird, called here the "judia" (the jewess), on account of its enlarged upper mandible. This bird hovers about cultivated fields and pastures, and may often be seen darting down from a tree or fence post to the surface of the ground and hopping back to the perch with a changa in its beak. Of course they can accomplish this kind act to the farmers and themselves only when the changa, on account of the condition of the soil and of the weather, is working at or just beneath the surface. Several other species of birds, the "mazambique," the "mirlo," one which happens to have the name of "chango," and others, are also enemies of the changa. These birds frequently take up their residence near cultivated fields and should, of course, be encouraged in this by the farmers, who should see that the law protecting the birds is vigorously enforced.

The common lizard also consumes considerable numbers of the changa, but, of course, it can work only in the daytime; besides, a lizard under 6 inches in length can only with great difficulty manage to swallow an adult changa. They may be noticed

frequently running about in cultivated fields and gardens carrying in their mouths changas which they are unable to swallow, but which they are determined to hold on to as long as possible. Many changas would probably escape from the small-sized lizards were it not for the fact that a large lizard follows the nonethical custom of dispossessing a weaker brother of his prey whenever an occasion offers.

Domestic fowls often learn to follow a plow and pick up the changas and grubs which are turned up with the earth.

It has been suggested that the horned toad of Mexico and southern United States might become an important enemy of the pest, but is extremely doubtful if that desert animal could withstand our humid climate; moreover, its habits are strictly diurnal.

The common toad of the United States, being nocturnal in habit, may prove of some use in intercepting occasional marauding changas, and arrangements have already been made to introduce it into this island.

Combined and intelligent effort toward judicious and persistent application of the remedies as advised in this report will keep the changa under control in Porto Rico.

The changa is justly considered one of the greatest difficulties the Porto Rican agriculturist has to deal with at present, but it is not sufficiently important to prevent the successful cultivation of any tropical product in the island. Indeed, its injuriousness has been frequently overestimated by discouraged planters; it has been blamed for the unprofitableness of various crops in many localities when poverty of the soil, fungus and bacterial diseases, poor agricultural methods, or unfavorable ecological conditions have been the real causes.

SUMMARY.

The changa is a comparatively large insect of the order of Orthoptera; its habits are subterranean and nocturnal; its food consists largely of roots of plants. The female lays her eggs in the galleries underground. The life of an individual is about one year. Its enemies are lizards and birds, but since these are strictly diurnal in habit, the changa suffers comparatively little from them.

The damage to crops in this island by the changa amounts to probably more than $100,000 annually. The crops injured most are cane, tobacco, and rice; a few crops are exempt from attack. The depredations extend over the entire year.

Comparatively little damage is done in clayey soils; moist, sandy loam is preferred. Saturation and extreme dryness of the soils are conditions which prevent the changa's operations.

The old method of protecting the roots of seedling plants with mamey leaves is more or less deleterious to the plants, but the great cheapness of this method commends it to the tobacco grower. The coarse wire-gauze cylinder is recommended for tomatoes and valuable plants.

Clean cultivation, both before and after planting crops, is recommended, because a large portion of the changa's ordinary food is thus cut off. Hilling up is also recommended where practicable. Special search with hoe or spade soon after a rain may be relied upon to some extent in small plats.

Plowing during the winter and spring months will bring to the surface numbers of the eggs or young larvæ, and this exposure to their enemies will result in the death of a large percentage of their number.

Trap lights are recommended for use on nights when the changa is flying in numbers. A dim light is nearly useless. A large lantern having a reflector and set at the edge of a field, or a lantern with no reflector set in the middle of a field, will give best results.

Arsenic or Paris green sprinkled on chopped grass is the best bait. This poison should be distributed in small patches or narrow rows, just beneath the surface of the soil.

Naphthalin placed in the ground about plants serves to repel the changa, but its use is warranted only in small and badly-infested areas.

SOIL CONDITIONS.

Soil management in Porto Rico is an important but most difficult problem. It is not uncommon to hear a casual observer remark that the soils are very fertile. Excepting virgin land and alluvial lands that are occasionally subject to overflow, however, this is far from the truth, if productivity is an index of fertility. It may be that all the elements of plant food are present in sufficient quantity, but, if such is the case, the plants are obviously unable to obtain them. This lack of availability, if it is such, may be attributed to the poor physical conditions which characterize most of the soils of the island. Climatic conditions and lack of good management are responsible for this condition. Freezing, which is so beneficial to soils, never occurs here. The rains are torrential, and therefore compact the soil; furthermore, they are often so frequent and copious that the soil remains saturated for weeks together. These adverse conditions are still further augmented by preventing beneficial biological processes which are essential to profitable plant production. These conditions present a problem in soil management which will include cultivation, manuring, and crop adaptation. Thorough cultivation, as practiced on level lands with moderate rainfall, is out of the question in the mountainous portion of Porto Rico, because such a system would permit the most valuable part of the soil to wash away to the sea as fast as it could be formed. Some happy medium between this and the present state of no cultivation will probably be the solution. That manuring is beneficial is demonstrated by the experiment with fertilizers reported below. Investigations along this line will form a feature of the experiment station work.

FERTILIZER EXPERIMENTS.

The effect of fertilizers upon the yield of sweet potatoes was very marked, as shown by the following table:

Effect of fertilizer upon the yield of sweet potatoes, variety "Martiniqua."

Plat number.	Date of planting.	Date of harvesting.	Kind of fertilizer.				Yield of tubers per acre.
			Acid phosphate.	Muriate of potash.	Nitrate of soda.	Cotton-seed meal.	
			Pounds per acre.	*Pounds per acre.*	*Pounds per acre.*	*Pounds per acre.*	*Pounds per acre.*
61 [a]	Dec. 2	July [b] 7					5,720
112	Dec. 17	June 27	225	113	37	113	12,044
113 [c]	Dec. 24	...do					16,260
114	Dec. 17	July [d] 2	188	188			19,270
115	...do	July [e] 2	225		75	150	15,055
116	...do	July [f] 7		150	75	150	9,763

[a] No fertilizer.
[b] One-third remained and were dug July 23.
[c] Barnyard manure applied at rate of 1,200 wheelbarrow loads per acre.
[d] One-fourth remained and were dug August 9.
[e] Three-fifths remained and were dug August 9.
[f] One-half remained and were dug August 9.

FIG. 1.—PORTO RICO STATION—FRUITS AND LEAVES; TWO VARIETIES OF MANGOES.

FIG. 2.—PORTO RICO STATION—FRUITS AND LEAVES OF THE SOUR SOP.

FIG. 3.—PORTO RICO STATION—FRUIT AND LEAVES OF THE BREAD FRUIT.

FIG. 4.—PORTO RICO STATION—STATION BUILDING AT RIO PIEDRAS.

cut practically no figure in the total exports, for they usually do not exceed one-tenth of 1 per cent of the total. With a climate equally as good as that of Jamaica or Costa Rica and a commercial position superior to them, why should not the growing of tropical fruits succeed?

Quite a number of individuals and several companies have recently engaged in the growing of citrus fruits, but as there are no commercial orchards on the island the possibilities are unknown. There is nothing to demonstrate what varieties of improved oranges may succeed best, what kind of treatment will be required, or what will be the cost of production. Some of the planters will undoubtedly make mistakes, and there is a demand for investigations along this line, which the station should supply. To supply this, however, will require the time necessary to bring orchards into bearing.

It is the purpose of the station to give prominence to the production of various kinds of tropical fruits. Arrangements have already been made for securing different varieties of these from various sources. A banana plantation has already been started, and nurseries of citrus fruits, mangoes, aguacates, and other sorts are now being started at Mayaguez. It is the intention to attempt the improvement of the fruits now being grown on the island by cultivation, cross breeding, grafting, and whatever methods give promise of good results.

FORESTRY RESERVATION.

Only a few remnants of the beautiful tropical forest with which Porto Rico is said to have once been clothed now remain. These remnants are practically all on Government lands and are constantly being robbed of their choicest trees. It has seemed advisable that a part of this Government forest land be set aside for a forest reserve, and the experiment station has, therefore, designated the tract of land most desirable for the purpose. This embraces somewhat more than 25,000 acres and, so far as could be ascertained, was all Government land. It is situated in the northeast part of the island, about Loquillo, and is the most elevated and rugged part. The annual rainfall there is about 150 inches, which, together with the rough character of the district, makes the land of very little agricultural value. Furthermore, the destruction of the forest endangers the farming lands below by subjecting them to frequent overflow. It seems very desirable, therefore, that no further destruction of the forest be permitted, and that this parcel be set aside as a forest reserve. A description and map, prepared by Mr. O. W. Barrett, of the station, were submitted to the proper authorities regarding such a reservation.[a]

[a] On January 17, 1903, the President issued a proclamation establishing the reservation under the name of The Loquillo Forest Reserve.

HERBARIUM AND INSECT COLLECTION.

An herbarium has been commenced and consists of about 300 species of the more economic plants, most of which are in duplicate, and a part of which are in triplicate, the object being to furnish the extras in exchange or give them to other institutions in lieu of their making the determinations. A considerable collection of the native woods of the island has also been brought together and is being prepared for exhibition purposes.

A collection of economic insects has also been commenced, and both this and the herbarium will be increased from time to time until they represent the flora and insect life of the island.

METEROLOGICAL OBSERVATIONS.

Immediately upon beginning experimental work at Rio Piedras a rain gauge was secured from the Weather Bureau and a record of the precipitation was kept, together with observations on the character and direction of the wind, the time of rains, and the character of each day as regards sunshine and clouds. Previously no such record had been kept at Rio Piedras, and as the Weather Bureau desired to continue the record the gauge was transferred to Dr. Todd, director of the insular normal school. As soon as the station became settled at Mayaguez the instruments in the care of the voluntary observer there were transferred to the station, and it will continue the observations, which will include maximum and minimum temperatures as well as rainfall.

Following is a table giving the monthly rainfall at each of four places since the establishment of the United States Weather Bureau in the West Indies. These include the latest available data, and being at the east and west ends of the island, as well as the north and south sides, they show the extreme variation in rainfall to which the island is subject.

Rainfall (inches) in Porto Rico, as recorded by the United States Weather Bureau, January, 1899, to December, 1902.

Locality.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Hacienda Perla:													
1899	7.19	3.98	6.51	18.78	6.72	11.47	10.55	9.92	15.43	16.53	28.13	4.92	140.06
1900	12.05	3.67	4.43	23.34	18.70	18.55	11.04	11.95	15.30	15.83	8.36	8.70	151.92
1901	6.07	1.85	11.03	7.05	16.26	25.34	33.58	8.19	16.10	14.16	16.43	11.67	167.73
1902	13.99	.24	7.25	9.94	19.83	32.92	10.08	8.13	10.06	6.06	......	......	....
Mean	9.82	2.44	7.30	14.78	15.38	22.07	16.31	9.55	14.22	13.14	......	......	....
San Juan:													
1899	2.92	.80	2.29	6.09	2.59	7.23	7.53	10.38	13.66	10.21	11.81	2.10	77.61
1900	3.93	2.13	1.57	5.92	3.83	7.53	6.33	7.00	3.05	8.11	4.50	2.39	56.29
1901	4.36	.50	4.60	.66	4.84	7.05	10.98	8.59	7.39	8.30	9.55	8.43	85.25
1902	12.45	.09	4.08	6.09	13.97	12.22	4.61	4.66	4.85	3.13	......	......	....
Mean	5.91	.88	3.12	4.69	6.31	8.51	7.36	7.66	7.24	7.44	......	......	....

Rainfall (inches) in Porto Rico, as recorded by the United States Weather Bureau, January, 1899, to December, 1902—Continued.

Locality.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Mayaguez:													
1899	......	......	......	......	......	......	14.41	19.02	......	8.73	3.52	1.04	....
1900	1.49	1.06	1.21	5.44	6.14	14.03	13.11	14.02	7.44	12.47	2.99	4.20	83.57
1901	2.19	.58	5.72	.58	11.87	10.44	17.06	9.86	13.00	11.27	12.84	2.08	97.49
1902	4.67	.39	.13	10.85	16.56	8.33	7.62	5.80	7.60	5.82	......	......	....
Mean	2.09	.51	1.76	4.22	8.64	8.20	13.05	12.17	7.01	9.57	......	......	....
Hacienda Armistad:													
1900	4.25	.80	1.00	1.10	2.80	16.30	5.50	2.20	4.80	4.46	3.83	4.22	51.26
1901	2.60	1.14	2.63	.32	6.30	4.84	......	6.03	7.97	6.30	13.97	3.10	55.20
1902	......	......	......	5.41	7.91	7.19	1.73	2.40	2.28	3.19	......	......	....
Mean	2.28	.65	1.21	2.28	5.67	9.44	......	3.54	5.02	4.65	......	......	....

PUBLICATIONS.

The publications issued by the station are Bulletin No. 1, on the Establishment, Location, and Purpose of the Experiment Station, and Bulletin No. 2, on the Changa, or Mole Cricket, in Porto Rico. These have been printed in both Spanish and English. Bulletin No. 1 gives a brief account of the establishment of the station, describes the farm that has been purchased for it by the insular authorities, and states what the equipment consists of. It also discusses the investigations already undertaken, as well as those that are contemplated, and announces the objects and purposes of the station.

Extracts from Bulletin No. 2 are made on preceding pages, sufficient in scope to give a clear idea of the matter contained in it.

It is the intention to issue two more bulletins in the near future, one on the soil survey and the other giving practical suggestions to coffee planters.

For a description of the island and a discussion of its climate, soils, agricultural conditions, products, and possibilities, the reader is referred to the annual report for 1901.

REVIEW OF IRRIGATION INVESTIGATIONS FOR 1902.

By Elwood Mead, *Chief of Irrigation Investigations.*

INTRODUCTION.

The rise in value of irrigated land and water rights has been the most significant change in the agricultural conditions of the arid region during the past year. In some sections there has been a marked increase in the irrigated area, but growth in this direction has not been so general or so important as the increase in prices. There are indications, however, that the extension of the farmed area will be more marked next year than this.

Several causes have contributed to bring about these rising values. Farming lands in Iowa, Illinois, Missouri, and Kansas have risen until in some sections they sell for double what they would have brought five years ago. This has led many landowners to sell out and move West, where land is cheaper, and has created an active market for both the improved and unimproved farms capable of being irrigated. Farming land in northern Wyoming, which three years ago could have been purchased for $15 an acre, now sells for from $35 to $50 an acre. Unimproved but irrigable land in the Yakima Valley brings $40 to $50 an acre, which is three times its value five years ago. Improved lands in Yellowstone Valley, Montana, have risen from $25 to $75 an acre.

Changes in the methods of conducting the range live-stock business have also enhanced the profits of irrigation and stimulated the rise in land values. Sheep and cattle are worth two or three times as much as they were ten years ago, and their owners can not afford to risk losses by neglecting to feed during winter storms, so they are buying hay and grain from irrigators in larger quantities, and at much higher prices than formerly. The injury to the range pasturage due to overstocking is also making it necessary to feed in winter, and is creating an imperative home market for irrigated products. In the Northwest the growing trade with Alaska and the Orient has greatly improved markets and prices, so that many farms which five years ago could be purchased for $20 an acre are now paying an annual profit of that sum.

Another potent factor in enhancing the prices of land and water was the passage of the national irrigation act. It made $6,000,000 immediately available for the construction of irrigation works by the National

Government. This fund has since increased until there is now more than $8,000,000 to use in building canals, reservoirs, or other works, as soon as the locations have been chosen and plans completed. The prospective benefits of these works have encouraged settlers along many streams, where the water supply is now scanty, to hope that in a few months, or at the furthest a few years, they will be provided with all the water they need, and have enhanced the value of both land and ditches.

The discussion of this act in Congress and the increased attention paid to irrigation by magazines and newspapers have had a tendency to increase emigration to the arid West. Some who come are genuine homeseekers, some are speculators. Many will be disappointed, because they have exaggerated the area of land which can be brought under cultivation, or believe that national aid means practically free land and free water for everybody. The rush to file on the public lands bordering streams has caused the homestead entries for the past year to reach a phenomenal figure.

The enhanced value of land and water will do much to promote the success of the national irrigation act. Many projects can now be carried out at a profit which a few years ago would have entailed a certain loss. These rising values have also benefited private enterprises. In many instances it has made canals profitable which have long been losing investments, and this fact has tended to stimulate private development. Many new projects are being considered by private capital at the present time, and in some States, Colorado especially, there never has been a time when as much work was being done in the construction of private storage reservoirs.

The extensive purchases of irrigable land by farmers from the humid States and the scramble to secure title to the public land along streams are bringing a large number of men to the arid West who know nothing about the methods of applying water to crops, or about the water-right questions created by the diversion and use of streams. It is probably true that more men will use the irrigator's shovel for the first time next spring than ever before since the settlement of the arid region began. These farmers ought to be helped to master the simpler practices of irrigation. The school of experience is wasteful of time, effort, and money. Another reason for such aid is the fact that every increase in the acreage irrigated enhances the need of economy and skill in the application of water to crops. The larger the number of homes dependent on a river the more important it becomes that there shall be a peaceable and just division of the water it carries. In order to bring about the largest and best use of streams those interested must know when water is needed, how much is required, and how it should be applied. That this is a general belief is shown by the growing demand for the bulletins

of this Office from farmers and from those engaged in the surveys and examination of locations for irrigation works. The requests for information and advice come from all sections of the country, from farmers who live under ditches, and from others who are planning to emigrate.

All that has been said with reference to assisting farmers to become skillful irrigators applies with added force to the need of promoting in every way the enactment of better laws for the establishment of just and stable titles to water. The national irrigation act makes State laws supreme in the determination of water rights and the administration of streams. This leaves the fundamental problem of irrigation exactly where it was when the investigations of this Office began. The need of effective water laws has, however, become more urgent because of the increasing number of irrigators and the new questions as to the relation of public and private works to each other which it will inevitably create.

The problems of irrigation fall into two distinct and clearly-defined classes. The first deals with the water supply and the location and construction of works to make it available. The second deals with the problems of those who own and operate irrigation works and of the farmers who live under them. The investigations of this Office deal with questions of the second class. It is endeavoring to clear up the confusion and uncertainty which now exists regarding water titles; to show the evils of speculative filings on water which threaten to put the farmer under a perpetual mortgage to the water grabber; to find out how much water it takes to irrigate an acre of land, so that the area which a stream will serve can be determined and settlers saved from wasting their time and money in improving land for which there is no water, and in connection therewith to promote the adoption of the best methods of distribution and use so that each stream may irrigate the largest possible area.

It is worth while considering what has been done to promote these ends during the past four years. The list of publications given later shows the scope and character of the work done. The methods of constructing laterals and small ditches are described in the Yearbook for 1900, and republished as Farmers' Bulletin 158. The application of water to crops is dealt with in Farmers' Bulletins 116 and 138, and in Bulletins 73, 81, 87, and 108 of the Office of Experiment Stations. Bulletins 86, 104, and 119 contain the reports of the measurements made to determine the amount of water required to irrigate an acre of land under varying conditions of soil, climate, and cultivation, and give the losses in transit through canals from seepage and evaporation, together with the causes which influence these losses. The studies of laws and customs are given in Bulletins 58, 60, 70, 100, 105, and 118.

The need of more information on these subjects is every year becoming more urgent. On many rivers there is more land under

cultivation than can be watered from the natural flow, and each season farmers suffer losses of crops from drought. In some valleys, like the Arkansas in Colorado, or the Salt in Arizona, the area covered by canals is double the area which can be irrigated without the aid of reservoirs. Where these conditions prevail a just division of the water supply is of great importance. Waste of water by one irrigator means needless loss of crops to another. One of the first steps in preventing this waste and loss is to know how much water should be turned into the head of a canal to supply the land it serves. The measurements made to determine this by the agents of this Office have been of great service to the arid West. Taken together they will in the near future afford an approximate basis for planning new works and estimating how much additional land can safely be brought under cultivation. The reports of these measurements for 1899, 1900, and 1901 show that enough water was taken into the heads of canals and ditches to cover the land irrigated to an average depth of 4.45 feet, or 4.45 acre-feet of water was taken from streams for each acre irrigated. If, therefore, seepage is disregarded, the flow of the stream in acre-feet divided by 4.45 would give the acres of land the water supply of the West would serve. But seepage can not be disregarded, as between one-fifth and one-third of the water turned into canals returns again to the stream, so that 3 acre-feet of water to 1 acre of land would be more nearly the average net duty at the present time.

It must not be assumed from the foregoing that any number of acre-feet of water can be arbitrarily assumed as the quantity required for an acre of land. All that the measurements seem to show is that between 4 and 5 acre-feet of water for each acre irrigated is not far from the average result for the whole arid region under present conditions and methods. Both these are changing in the direction of a higher duty. In planning new works or in dividing the water of a river among canals already built no arbitrary duty of water can, however, be taken as a guide. Local conditions must be studied, and one of the valuable features of the work of this Office is the fact that its range of territory and conditions is so wide that some of the measurements made will serve as an approximate guide for any work to be done.

The measurements of the water used in irrigation have done much to promote two reforms in the irrigation practice of the arid region. They have shown that the losses from seepage are much larger than had before been supposed. This is leading to better construction and maintenance of canals in order to lessen this waste. They are showing the influence which water-right contracts exert in promoting thrift and economy or in encouraging wasteful or excessive use of water. When streams carried a surplus and water had little value the chief object of canal companies was to secure customers, and many of the earlier contracts were loosely drawn. The simplest method of charging for

water was by the acres irrigated and many contracts provide for payment of water charges on this basis.

Under such contracts farmers have no incentive to economize. The more water they use on an acre the more they are getting for their money, and, in many instances, this has been the chief cause of the wasteful use of water. In a few places the agents of this investigation have induced companies to make changes in such contracts by charging for the volume delivered. The saving has been so marked that the reform will go on. In a comparative test made in the Pecos Valley in New Mexico those who paid by the acre used enough water to cover the land to a depth of 2.57 feet. Those who paid for the quantity used applied only water enough to cover the land to a depth of 2.04 feet, a saving of 20.6 per cent. An increase of one-fifth in the area irrigated would be no insignificant gain. In one of the tests made in Idaho those who paid for water by the acre used enough to cover their land to a depth of 5.73 feet. Those who paid for what they used got along with enough to cover the land to a depth of 4.14 feet, a saving of 1.59 acre-feet for each acre, or nearly 28 per cent.

The studies of the duty of water throw much light on the amount of storage which will be required in order to make complete use of the water supply. With very few exceptions the rise and fall of streams does not correspond to the varying needs of crops. There is too much water at some times and too little at others. The function of the reservoir is to act as a regulator, to hold back water when it is not required and supply it when it is.

On some streams the amount of regulation required is small because their flow is well maintained throughout the irrigation period. Rivers like the Grand, Green, and Bitter Root, which rise in lofty mountains with timber-covered slopes, belong in this class. The snow melts late and the water runs off gradually. Natural lakes of large size serve to regulate other rivers like the Yellowstone and Snake. On the other hand, rivers which head in mountains from which the timber has been removed or in mountains of low elevation are torrential in character, carrying the bulk of their flow in sudden floods. These irrigate only a small area by direct diversion, and reservoirs are a necessity.

In all cases the aim should be to make the largest practicable use of the natural flow and limit storage to the regulation which this requires. The cost of building and operating reservoirs is an added tax on water users, from which all the land which can be irrigated directly from the stream is relieved. In order to determine how much water has to be stored and how much can be applied directly to the land, it is necessary to ascertain both the months when water is required by irrigators and the percentage of the total supply needed each month. To do this, the water used must be measured, and measured where irrigators have all the water they need. Comparing measurements of

this character with the flow of streams gives a scientific basis for the planning of storage works. It will require several years' study on each stream in order to avoid errors caused by seasonal variations and secure a safe average, but the results of a single year's study show how valuable this data is destined to be in those sections where water is scarce and land abundant. In order to illustrate this, a few diagrams have been prepared showing the results of comparing the percentages of water used in the different months of the irrigation period with the run-off of the stream from which the water was taken. The stream flow has been taken from the records of the United States Geological Survey; the water used, from the measurements of this Office.

The tables and diagrams which follow indicate approximately the extent of storage which will be needed to use all the water of three streams where irrigation is already important.

Percentage of annual flow of rivers discharged each month.

Month.	Yakima River, Washington.	Gallatin River, Montana.	Boise River, Idaho.
	Per cent.	*Per cent.*	*Per cent.*
January	7.8	3.8	5.5
February	7.1	3.4	2.7
March	4.7	3.6	3.9
April	7.1	3.8	14.5
May	13.8	6.6	20.8
June	19.1	29.1	25
July	13.2	24.7	12.2
August	4.7	7.1	3.7
September	2.4	4.8	2.4
October	2.4	4.7	2.9
November	6.3	4.4	3.1
December	11.4	4	3.3
Total	100	100	100

Percentage of flow of canals during irrigating season discharged each month.

Month.	Sunnyside Canal, Yakima River.	Middle Creek Canal, Gallatin Valley.	Rust Lateral, Ridenbaugh Canal, Boise River.
	Per cent.	*Per cent.*	*Per cent*
April	5	....	3.2
May	12.8	....	17.5
June	14.4	29.8	17
July	20.1	39.9	14.6
August	23	20.7	18.6
September	13.3	9.6	16.7
October	11.4	....	12.4
Total	100	100	100

DRAINAGE INVESTIGATIONS.

To those not familiar with Western conditions the statement that along many streams drainage stands next to reservoirs as a means of increasing the cultivated area will seem surprising; nevertheless it is

Fig. 1

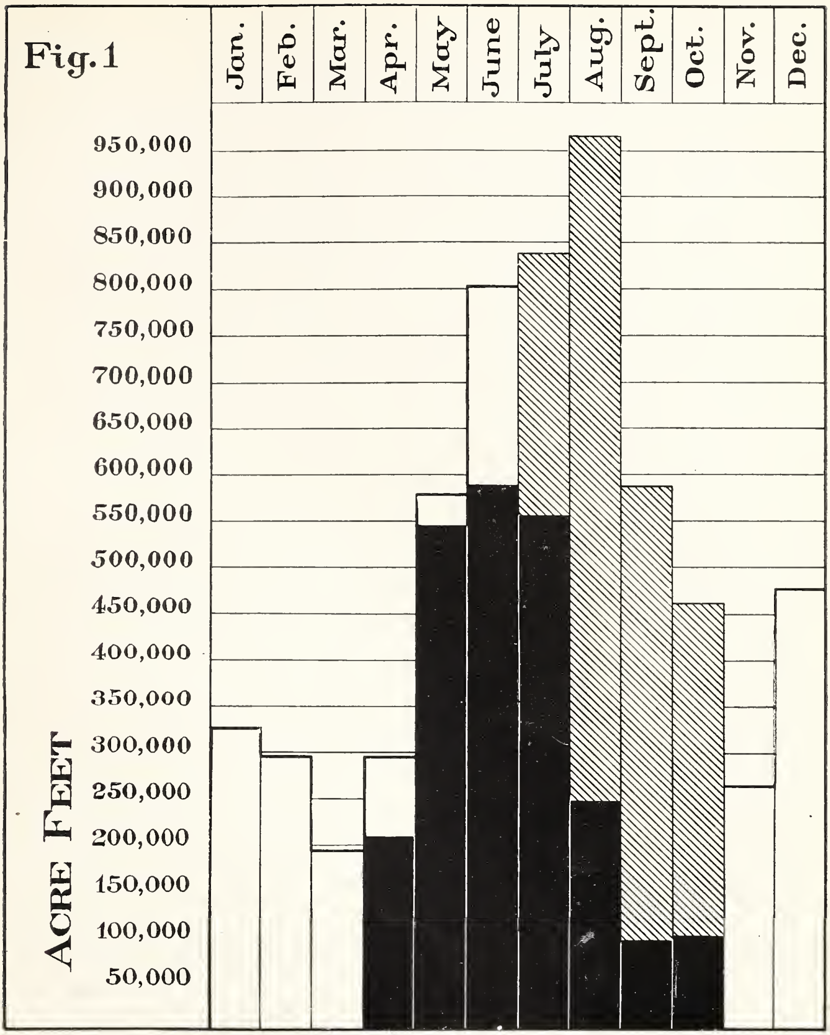


Fig. 2

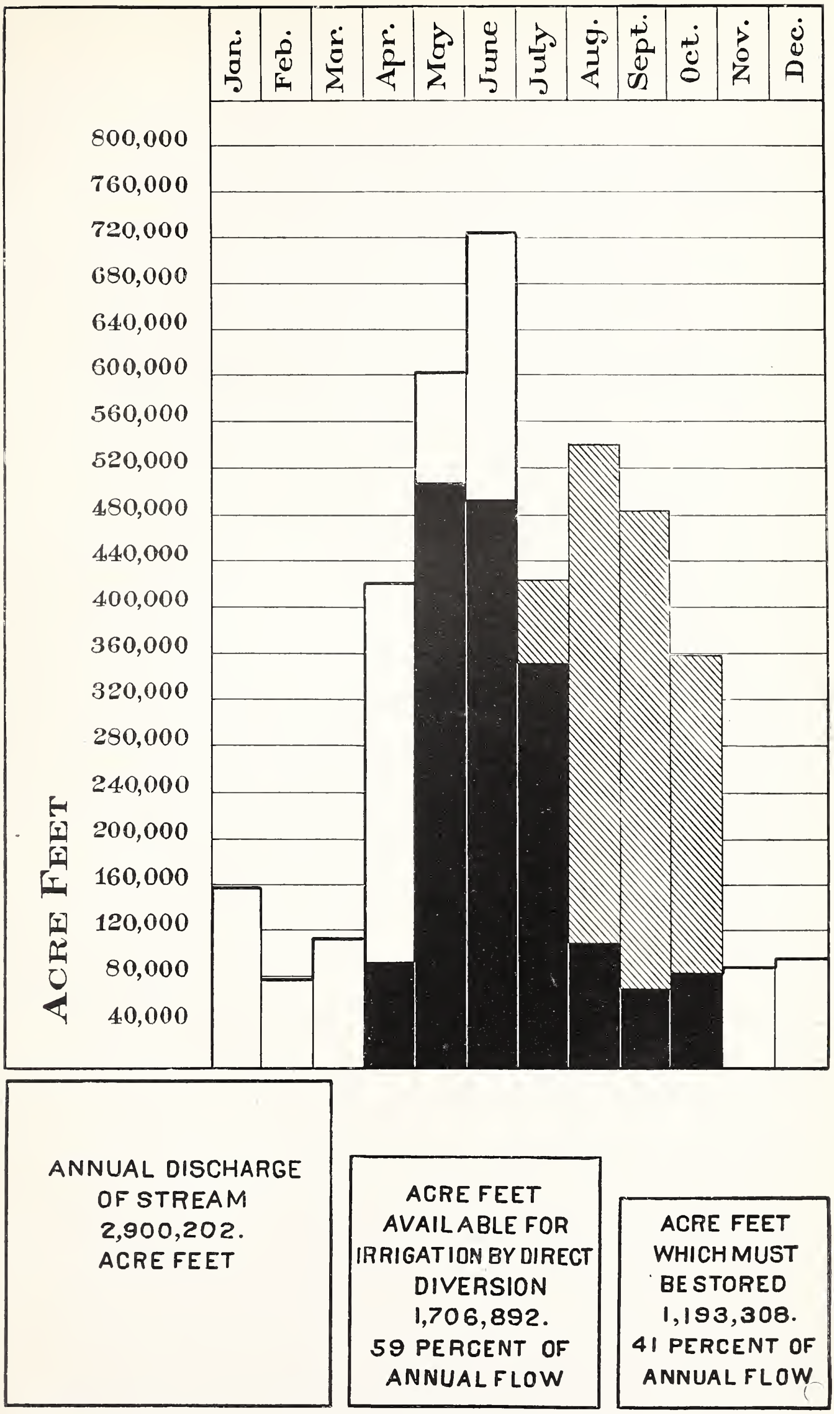
ANNUAL DISCHARGE OF STREAM 4,202,013. ACRE FEET

ACRE FEET AVAILABLE FOR IRRIGATION BY DIRECT DIVERSION 2,637,094. 55 PERCENT OF ANNUAL FLOW

ACRE FEET WHICH MUST BE STORED 1,564,919. 45 PERCENT OF ANNUAL FLOW

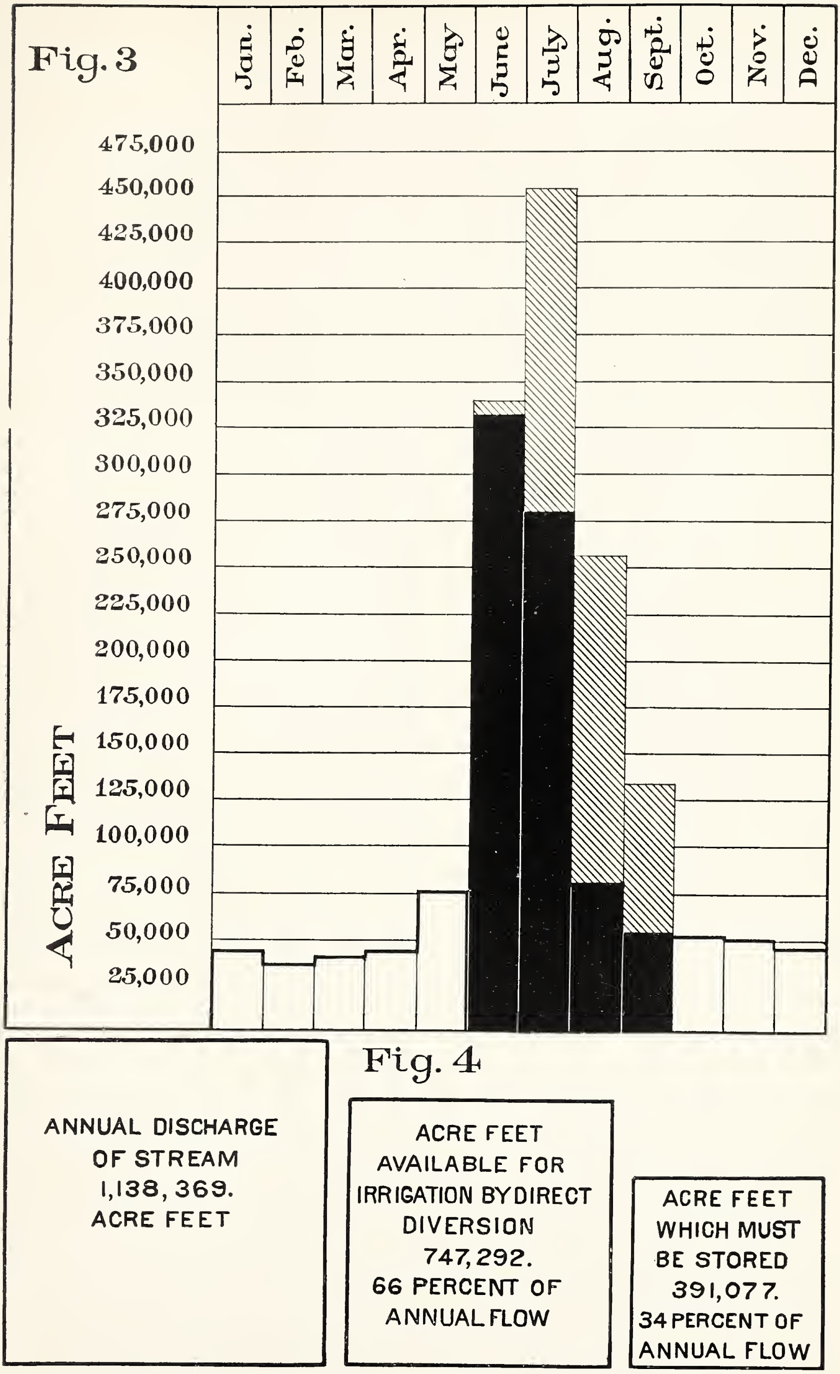
IRRIGATION INVESTIGATIONS—DIAGRAM SHOWING FLOW OF YAKIMA RIVER, WASHINGTON, AND STORAGE REQUIRED FOR ITS COMPLETE USE IN IRRIGATION.

White areas represent amount of flow during nonirrigation period and unused flow during April, May, and June. Black areas represent amount of flow which could be used by direct diversion. Hatched areas represent the volume which must be stored and the time of its use.



IRRIGATION INVESTIGATIONS—DIAGRAM SHOWING FLOW OF BOISE RIVER, IDAHO, AND STORAGE REQUIRED FOR ITS COMPLETE USE IN IRRIGATION.

White areas represent amount of flow during nonirrigation period. Black areas represent amount of flow which could be used by direct diversion. Hatched areas represent the volume which must be stored and the time of its use.



IRRIGATION INVESTIGATIONS—DIAGRAM SHOWING FLOW OF GALLATIN RIVER, MONTANA, AND STORAGE REQUIRED FOR ITS COMPLETE USE IN IRRIGATION.

White areas represent amount of flow during nonirrigation period. Black areas represent amount of flow which could be used by direct diversion. Hatched areas represent the volume which must be stored and the time of its use.

true. This is due to the fact that large areas have been rendered unfit for cultivation by an excess of water. Drainage will restore these lands to productiveness. In addition, much water is lost through evaporation from the ponds and marshes which have been created. Drainage will make this water available for us elsewhere. Many of the farms which have been injured by the rise of seepage water are highly improved. The aggregate area is surprisingly large and it is being rapidly extended; hence the preparation of drainage plans is not a local but general problem, which concerns, more or less directly, all the older irrigated sections of the West, and will in time involve valleys now being brought under cultivation.

During the past season this Office has been making surveys and preparing plans for draining the seeped lands around Fresno, Cal., and has made an investigation of some of the districts of Colorado where drainage is most needed. The work in California was under the direction of Prof. O. V. P. Stout, professor of engineering in the University of Nebraska and agent and expert in these investigations. Plans for the drainage of 25 square miles of vineyard and fruit lands are being prepared. These surveys should have begun earlier in the season, and a series of test wells to determine the rate of rise of water in the soil after water was turned into the canals would have been of great value, and studies of this kind should be carried on next year. Professor Stout's report has not yet been received, but it is believed that additional data should be gathered in order to determine more exactly the size of drains required.

The work in Colorado was not begun until after the irrigation season was nearly over, and owing to the fact that it was a year of unusually scanty water supply, the ground water was so low that the process of seepage could not be studied to advantage. Borings were made and levels taken to determine the effect which drains in operation had upon the water line of the soil and whether a system of intercepting or cut-off drains in single lines is not more effective than a system of collecting drains. This work was under the direction of Mr. C. G. Elliott, agent and expert in charge of drainage investigations, who from these studies and some soil borings has reached the following conclusions:

(1) Much valuable land under irrigation has been destroyed by seepage, and the process is going on in certain quarters at a rapid rate.

(2) That this land can be reclaimed, and that land now threatened with the effects of seepage can be protected from injury by simple methods of drainage.

(3) The simplest and most effective method of drainage is a cross ditch, either open or closed, constructed across the slope where seep water first manifests itself parallel with the supply ditch and between it and the injured land. Whatever may be done subsequently, this is the first step.

(4) The depth of drains must in most cases be 5 or 6 feet in order to be effective.

(5) For the protection of extensive tracts large ditches of considerable length will be required, in the construction of which the cooperation of land owners will be necessary, and this work can only be done effectively under the provisions of a State drainage law.

I believe that this work should be continued and that field studies should begin in the spring and include the following:

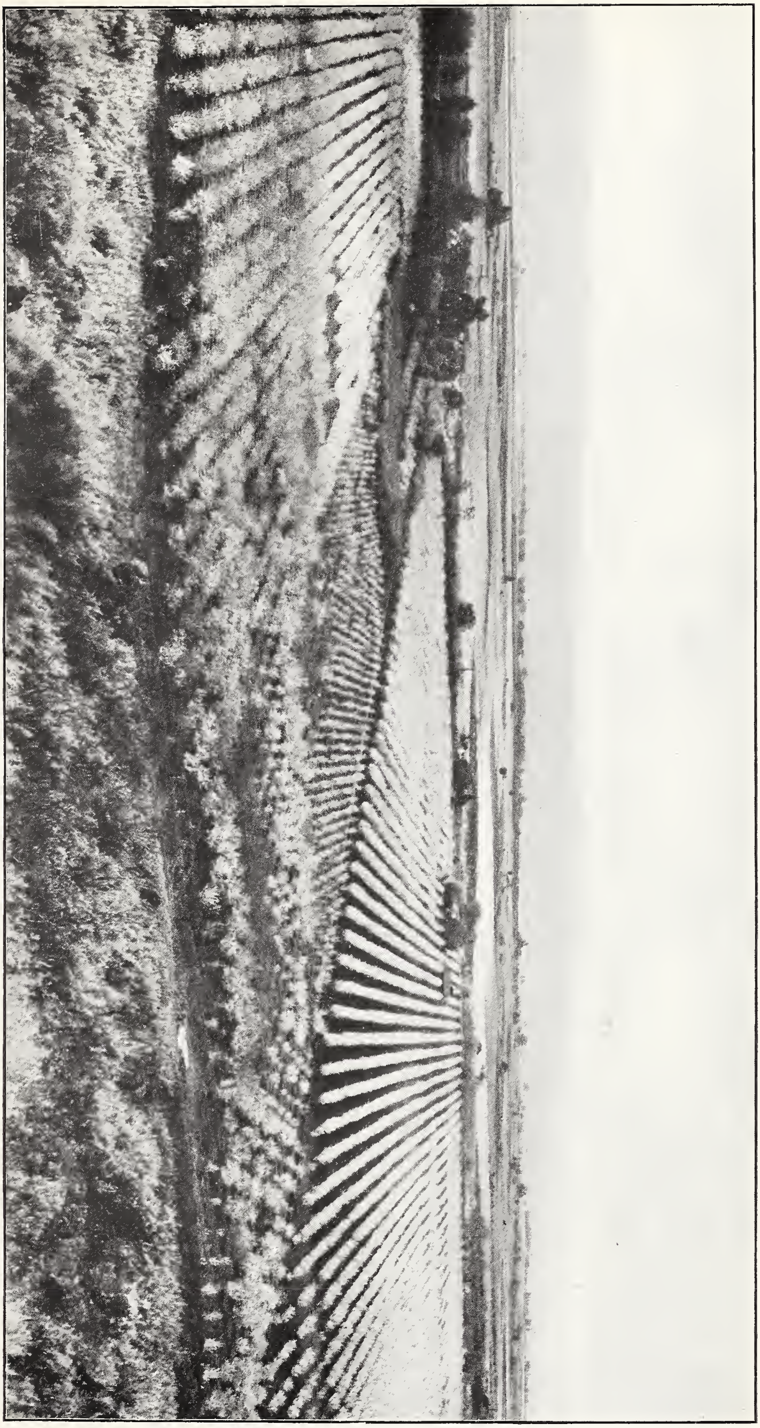
The rate of losses from canals and the location of these leaks, the rise and fall of soil water in land which lies below such ditches, the rate of the movement of water through the soil, and the quantity of water which should be removed by drains for the purpose of reclaiming land already too wet, or to arrest the progress of seepage.

For the determination of these points, canals must be gauged repeatedly, sections of different slopes should be selected, and wells or curbs 8 feet deep or more, for recording the rise and fall of soil water, should be sunk. These should be placed at varying intervals across and down the slope, beginning with the irrigating ditch and extending down the slope as far as may be necessary. The elevations of the ground at each well should be obtained and recorded, and measurements of the height of water made each week during the season. From these data the quantity of water needing to be removed, and which must be provided for, can be approximated, as well as its rate of movement and behavior.

The different conditions under which seeped lands occur should be studied while irrigation is progressing and until after the water in the ditches is shut off.

In Grand Valley, on the western slope of Colorado, the conditions are such as to render drainage indispensable in the near future, but the preparation of plans for this drainage is comparatively simple. The great need is to arouse the people into concerted action before the lands have been so badly injured as to discourage them. The work should be one of prevention as well as cure, and it is hoped that the facts gathered by Mr. Elliott will apprise those concerned of the gravity of the situation and lead to the needed cooperation. The work should be continued next season and be taken up early in order to study the losses from canals when water is first turned in. The abundance of water in this valley has led to overirrigation by farmers, while the ordinary loss from canals is augmented by the continued flow of water through both the main canal and its laterals. Water is run throughout the winter, and hence there is no opportunity for the land to dry out.

This Office has had many inquiries relative to underdrainage from the South, to which it seems proper to give some systematic attention. Bottom lands there when drained are much more valuable for crop-



IRRIGATION INVESTIGATIONS—IRRIGATED ORCHARDS IN THE SAN JOAQUIN VALLEY, CALIFORNIA.

FIG. 1.—IRRIGATION INVESTIGATIONS—PUMPING FOR IRRIGATION IN A SANTA CLARA VALLEY ORCHARD, CALIFORNIA.

FIG. 2.—IRRIGATION INVESTIGATIONS—ORCHARD IRRIGATION IN SANTA CLARA VALLEY, CALIFORNIA. SUPPLY DERIVED FROM PUMPING.

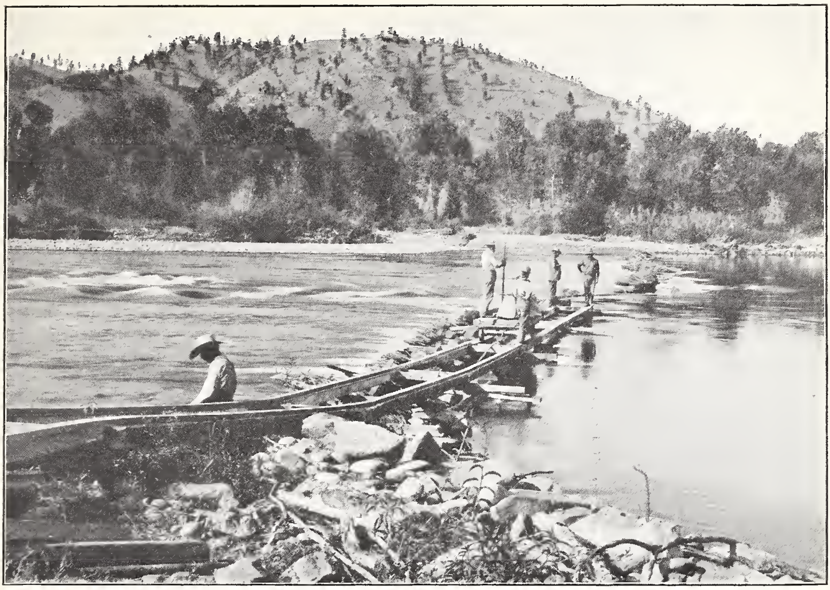


FIG. 1.—IRRIGATION INVESTIGATIONS—REPAIRING BRUSH AND ROCK DAM, YELLOWSTONE RIVER, MONTANA.

FIG. 2.—IRRIGATION INVESTIGATIONS—HEADGATES AND WATERWAY, SKALKAHO CREEK, BITTER ROOT VALLEY, MONTANA.

ping than the hill lands. Many of the landowners appreciate this fact and would undertake this work if they had a knowledge of the proper location and methods. Some encouragement by way of examination and advice will go far toward the adoption of plans for increasing the productiveness of many areas. Tile works should be encouraged to locate in that region. Here is the place for small factories requiring little capital to build. If the Department, through its appointed agent, could make a preliminary examination of some of these projects, much encouragement would be given to drainage improvement in the South.

There is another division of this subject which needs attention. This is the control of hill streams which flow through bottom lands to river outlets. The handling of such streams in a way not to injure bottom lands which have been reclaimed by drainage is a problem which has not as yet been well solved by drainage engineers, and to which this Office can appropriately give some attention, both through the collection of data and a comparative inspection of the plans and methods now in use. The construction of levees for the protection of drainage districts, either by private enterprises or under districts established under State laws, is not as well understood by those called upon to plan the work as it should be.

AGRICULTURAL ENGINEERING.

In many parts of the West the growing scarcity and greater value of water is leading to the use of sources of supply which were at first neglected. The rise of soil water under many irrigation canals has led to a large increase in the number of wells and pumping plants in the districts watered. In other sections vigorous search is being made for subterranean sources, and whenever an underflow is found it is being utilized. In the Santa Clara Valley in California over 1,500 pumps are now supplying water to irrigators, and along many Western rivers there are now more pumps than ditches. (Pl. XL.)

As a result of this increased employment of pumping, this Office receives a large number of inquiries asking the cost of lifting water, the kind of pump suited to particular conditions, the kind of power best suited to the work, the amount of water required for the growing of crops; in fact all of the data which will enable farmers to determine whether pumping can be employed at a profit is being repeatedly called for. In order to answer these inquiries, it has been necessary to make a systematic study of the subject of pumping, and a number of the agents and experts engaged in this work have given much attention to this subject. A number of the larger manufacturers of pumping machinery have also expert engineers engaged in similar lines of investigation and have been most generous in cooperating

with the Department in this work. The number of firms from which aid and information have been received prevents anything more than this general acknowledgment.

During the past few months the inquiries regarding pumpin · have been accompanied by inquiries regarding the utilization of canals and streams for power purposes. It is manifest that by answering these inquiries the Department can do much to promote both the conven ence and profits of farming, and, wherever it has been possible, the information asked for has been furnished. Necessity has compelled giving more and more attention to features of agricultural engineering which do not at first glance seem to be related to irrigation, but which are shown to be by experience. The growth of drainage studies and the applications of power to pumping and farm work are illustrations of this development. In addition it is believed that in the comprehensive study of agricultural engineering, including problems relating to the laying out of farms, the construction of farm buildings, and the determination of the best types of machinery to be employed, this Office has an opportunity to render American agriculture an important service in a long-neglected field.

Within the past fifty years the increased use of machinery has worked as radical a revolution in farm life and farm work as it has in manufacturing. It is to the use of machines to take the place of men that the United States owes a large part of its agricultural preeminence. This country leads all others in both the manufacture and use of agricultural implements, and in order to retain its supremacy its continued progress in the designing and use of labor-saving devices must be provided for. In order to do this there is need that farmers shall be trained in mechanical principles, because the evolution in methods now going on is more rapid than ever before; farm machinery is changing from simple forms and is becoming highly complex. The traction engine and the automobile have both an assured place in the economic operations of farms. Improvements in electrical transmission render it certain that water power is to be used more largely than in the past. Farm buildings, instead of being simply storage places for grain or shelters for live stock, are becoming as complex in their design and uses as factories. There is need of investigation and study in regard to the laying out of farms, the drainage and sanitation of farm buildings, and of securing the greatest effectiveness and economy in both the design and use of material for their construction.

WATER-RIGHT PROBLEMS OF THE ARID REGION.

The extent of irrigated agriculture in the arid region depends on two things—the natural resources (the area of land which can be irrigated

and volume of water to render it productive) and the laws and institutions which will provide for their union and use. Much of the land and a large part of the water supply has passed into the hands of private owners and is no longer subject to disposal by the public. A portion of both still remains public property. There is a great contrast, however, between the character of the titles to land and to water, whether in public or private ownership. It is known that the public land belongs to the Federal Government. The respective spheres of State and national authority over public water supplies are uncertain, and, in some States, any public ownership, or the right to exercise any sort of public control, is questioned. The boundaries between public and private lands are clearly defined, but the extent of the appropriations of water, or the amount which remains yet to be disposed of, is largely a matter of conjecture. Titles to land are definite and secure, but there is continuous litigation and controversy over water rights. The reason for this is that the public land has been disposed of under an orderly and systematic procedure, which provided for a complete record of filings, for supervision of the issuance of patents, and for a record of all changes of ownership thereafter, while the procedure for the establishment of titles to water has been left to the uncertain process of evolution under the influence of the interested parties. Anyone who desires can trace from its beginning to its final completion the record of title of every quarter section of land within the arid region. In only two States is there a complete record of water rights. Yet the ownership of a stream, or, what amounts to the same thing, the right to control its use in irrigation, is as important as the ownership of the land which irrigation makes fertile. The statement of President Harrison, that "whoever controls a river practically owns the land it waters, no matter who has the title to that land," voices an economic truth whose importance can not much longer be disregarded. In the arid West land is abundant, water is scarce. Without water the land has little value for agriculture, and whoever controls the water supply is able to determine the location of the acres which shall be reclaimed, and to condemn other acres to perpetual aridity. The scarcity of water and the impossibility of increasing the supply gives to whoever controls a stream possession of an absolute monopoly, with the power to determine not only where men shall live but to fix the conditions of their industrial life. Furthermore, the transfer of water to private ownership does not affect the present alone. It will shape the life of this region for generations to come.

In the light of these facts there does not seem to be any question that the West would have been immeasurably benefited if the National Government when it opened up Western lands to settlement had dealt with streams as it dealt with lands, placed their disposal under public supervision, measured their flow as it surveyed the lands, and recorded

and supervised filings on water with the same care and system that it has recorded and inspected filings on land. Nothing of the kind was attempted. The potential value of Western rivers was overlooked, and titles to water were left to be established under local laws and customs. In the absence of public supervision and of definite laws for the disposal of streams, men diverted and used their waters without regulation or restraint, and, so long as there was enough for all, the belief that water, like air, should be free for all, prevented adequate legislation by any one of the arid States or Territories. It was not until fields began to suffer from drought, until more ditches had been built than could be filled, that the settlers began to realize that in order to make a working policy out of the doctrine that water should be as free as air, it is necessary that water shall be like air, equal to the needs of all. Hence State laws followed rather than preceded the diversion and use of streams. The early water rights, and many of the later ones, were not established by law, but by prescription. Under the doctrine of appropriation, whoever diverted a stream acquired thereby the right to control for all time so much of the stream as he had diverted or claimed to have diverted, the extent and character of the right being determined largely by local ideas and practices.

Speculative filings on water began when it became manifest that many streams would not meet the needs of the settlers along their banks, and that it was water rather than land which would control the value of the irrigated farm. No one who has not made a study of the character of these speculative filings has any just appreciation of their significance or the manner in which their existence is likely to influence future development. It is a matter of history that the land grabbers have been in large measure successful, although subjected to rigorous supervision, and large areas have been acquired, not by settlers, but by those who expect to sell to settlers. Speculative land filings have been more than paralleled by the filings on water in order to secure speculative control of streams. Those who filed on water had a clear field. Neither the State nor the nation imposed any limitations on their claims, and in only a few States is there any adequate safeguard against the establishment of excess rights to water through the medium of court decrees.

The chaos, the uncertainty, and the danger of future abuses which have come from this lack of public regulation and control is fully appreciated by farmers under irrigation, but is not understood elsewhere. The statutes which govern the filing of claims to water in most of the arid States are so loosely drawn that appropriations of excessive amounts have been the rule rather than the exception. The record of water-right filings given in Bulletin 100 of this Office can be duplicated in other States. The water claimed from one small

stream in California would serve to irrigate more land than is likely to ever be brought under cultivation in the whole arid West. The titles to water from the streams draining the eastern slope of the Rocky Mountains in Colorado, which have been adjudicated and declared vested by the courts, amount to far more than their total discharge. This does not mean that all the water is used, but it does mean that the holders of these titles can control its use. On scores of streams, where as much water runs to waste as is used, the total volume held to have been appropriated, in the various lawsuits over water rights, is not only largely in excess of the volume actually used, but often in excess of the total flow of the stream. Where this situation exists those who propose building new works are confronted by the question whether these decreed rights are to control the water which has been thus declared appropriated, or whether existing ditches are to be limited to their present use. Until this has been answered, the rights of settlers under new works will be insecure and every improvement they make will be like an improvement on a town lot the title of which is defective. These excess rights should either be upheld or set aside, and this should be done in the immediate future for the protection of both those now using the streams and those who may desire to do so.

But filings on more water than streams carry, and decrees establishing rights to more water than has been used, are not the only dangers of the present situation. There are a number of other water-right questions which remain to be answered before many farmers under irrigation can feel secure as to their future. One of these is the conflict between the doctrine of appropriation and the common-law doctrine of riparian rights. In Montana, Wyoming, Colorado, Utah, Idaho, Nevada, and the Territories of Arizona and New Mexico the common-law doctrine of riparian rights has been abrogated, either by statute or court decision. In these States and Territories the law sanctions the complete use of the water supply, but in eight other States—Texas, Kansas, Nebraska, the two Dakotas, Washington, Oregon, and California—which are in part humid and in part arid, the riparian doctrine is recognized, and it is uncertain how much of a stream's flow can be diverted for use in irrigation. This uncertainty has come about as a natural if not inevitable result. The humid sections of each of these States were first settled and constitutions were adopted and statutes enacted before the importance and needs of irrigation were understood. Nebraska was a wealthy and populous State before it was admitted that the western third was arid. The riparian doctrine of Washington and Oregon is well suited to conditions west of the Cascades, and if its operations were limited to that section no harm could result. When men began to build ditches in the arid sections of these States they secured the passage of laws recognizing the doctrine of appropriation and of priority as a means of defining

their respective interests in streams. These laws were passed apparently without any opposition from the owners of riparian lands. In this way streams of eight States were made subject to two doctrines directly antagonistic in principle. In all of these, except Washington and Kansas, both doctrines were given unlimited force and effect; in these two the doctrine of appropriation was limited to the arid belt.

The conflicts growing out of this have led to prolonged and costly litigation; but, as each decision had to deal with the special facts submitted, they have seldom established general principles, and have not always been consistent with each other. It is to these decisions, however, rather than to statutes that we must look for the nature of water ownership in each of the States where the two doctrines now operate. In Washington and California they appear to make the riparian landowner a privileged appropriator, who can take water away from a nonriparian farm, no matter how long it may have been irrigated. In California the situation is well stated by a commission of the Water and Forest Association of that State, which has recently drafted a proposed code of water laws for California. Speaking of riparian rights, it says:

> In respect of riparian rights, so called, we propose certain sections, limiting the right of a riparian owner to the water needed and necessary for use on his land and preventing him from resorting to a writ of injunction to prevent some one else from putting the water to a beneficial use when he is not using it and does not need it.
>
> Here we were confronted with the question whether the legislature can, legally, and without violating the constitution of the State, or of the United States, thus limit the right of a riparian owner to the necessary beneficial use of water and prevent him from standing in the way of a beneficial use of it by others merely that it may flow past his land unused.
>
> That it is of supreme importance to the State that this should be done, if it can be done legally, the commission was unanimously agreed; but upon the question whether the legislature has the power to do it or not the commission was divided.

In the establishment of rights to water, each State has been a law to itself. The water decreed to have been appropriated in each State is enormous in volume and of great financial value, but almost nothing has been done to determine the respective rights of appropriators in different States to the water of interstate streams. The Rio Grande rises in Colorado and flows into New Mexico. The priorities and amounts of appropriations of many ditches which divert this river in Colorado have been established by court decrees, but these have paid no attention to the rights of ditches in New Mexico, although they are the oldest now in use on this continent. Water is diverted from the Arkansas River in both Colorado and Kansas, but the rights of Kansas ditches are ignored in the adjudications in Colorado. The North Platte River rises in Colorado, flows through Wyoming, and crosses Nebraska. There is one set of priorities in Colorado, another in Wyoming, and a third in Nebraska. Each has been established

without reference to the other, and there is no statutory method for determining their respective rank. Similar examples might be multiplied indefinitely. They present a perplexing problem to the legislator and to those interested in irrigation works. As the use of water increases, the need of an adjustment of these interstate rights will become more urgent. It has already led to a suit by Kansas against Colorado, and other suits will follow if some more speedy and economical mode of settlement is not reached. If it shall be decided that priorities must be recognized across State lines, it will then be necessary to determine the relative order of these rights in the several States through which a river and its tributaries flow. How is this to be done? Is this table of priorities and amounts of appropriations to be arranged by an agreement of the several State authorities, or is it to be done by some national tribunal, or by the courts? If by the latter, then the litigation of the past is but a suggestion of what is before irrigators in the future. In any event it needs to be determined, and as soon as possible, whether appropriations are to be recognized across State lines; and if this is to be done, then the determination of the rank and amount of the rights already vested should be undertaken at the earliest possible moment. The present uncertainty is a source of constant anxiety and dread to farmers and ditch owners on both sides of a State boundary and should be removed in order to determine where settlers can safely locate in the future.

The adjustment of the conflicting claims of appropriators in different States is not the only complication connected with interstate water rights. Many interstate streams rise where the riparian doctrine has been abrogated. They flow into States where the doctrine of appropriation has no standing and where riparian land owners are entitled to have the streams flow as they were wont to do from time immemorial. Sooner or later it will have to be determined whether the riparian claimants on the lower section of a river or the appropriators near its headwaters have the paramount right to the water supply.

Sooner or later the conflicting claims of navigation and irrigation will require adjustment. The water from the eastern slopes of the Rockies finds its way into the Missouri and Mississippi, both of which are navigable rivers. The tributaries of these rivers are already diverted by thousands of ditches. A few reservoirs have been built to store the floods, and plans are being laid for the conservation and largest possible use of these streams in irrigation. These plans can not be carried out without bringing actively to the front the question of whether the farm above or the steamboat below is to have first claim on the water supply.

Before development proceeds much further there should be some common agreement regarding the nature of a water right. It should be settled beyond question whether it is the amount of the recorded

claim, the carrying capacity of the ditch, or the needs of the land irrigated which determine the amount of an appropriation. In the adjudications of water rights thus far held, sometimes one of these conditions has been the basis of the right, sometimes another. Some claimants have had decreed to them rights to ten times the water which has ever been diverted or used. In some instances titles to water have been declared vested before the ditches for its diversion were built. In other cases, rights have been held down rigorously to the actual needs of the lands irrigated. The result is confusion, injustice, and uncertainty, and an entire absence of any basis which would serve as a guide for the just division of water between irrigators. There are thousands on thousands of water users in the West whose rights have never been defined. Neither they nor anyone else knows whether they are entitled to what they claim, how many other claims are superior to theirs, and how many are inferior. There is no method at present by which these titles can be finally settled. The courts are open, but it is rare that any court has jurisdiction over all the watershed of a stream. Besides, in the absence of special statute, the ordinary legal remedies are wholly inadequate. A can compel B and C to have determined the rank of their rights with respect to his own; but A can not compel B and C to have their rights with respect to each other adjudicated. Those who oppose public control say that this matter should be left to the irrigators and ditch owners to settle, either by friendly agreement or in the courts. To say that the few people who now use or claim Western streams shall make among themselves an agreed division of them is to ignore the rights and interests of the multitude of settlers who are to come hereafter; is to treat the rains and snows which form streams as a private and not a public resource. It would be equally as wise and just to say that the range stockmen, who now pasture their flocks and herds on the public grazing land, should be authorized to divide it up, determining for themselves how much each one shall own, and shutting off the rest of the country from any share in what is now a common property.

Laying aside the evils of such a policy, it is one which could never be put into practical operation. Neither irrigators nor range stockmen would agree. It was the failure of appropriators of water to agree among themselves which led to the establishment of public control in the States of Nebraska, Wyoming, and Colorado. It is the failure of appropriators to agree among themselves which causes the harassing and expensive litigation in the other States. Physical difficulties alone will prevent friendly agreements. The appropriators of a single stream could never be got together, much less the appropriators of a river and all its tributaries. The Platte River drains more than 40,000 square miles and its water supply is diverted by more than 2,000 ditches. The mere statement shows the absurdity of

an attempt at a voluntary agreement, yet the experience of both Colorado and Wyoming has shown that justice can be done only when the main stream and all its feeders are dealt with as one common supply, the rights to which are interdependent. The upper ditches on the Humboldt River are 300 miles from the farms at the lower end. The miles of sagebrush and the intervening mountains are of themselves obstacles sufficiently serious to prevent anything like a voluntary agreement regarding the division of the water supply, and similar illustrations are to be found all over the arid region. Even if all the appropriators can be brought together, those above will not willingly surrender the advantage which position gives them. The attempt to reach an agreement without public supervision has been made and has failed on scores of streams, and, even if it were possible, would inevitably be a selfish arrangement. Appropriations of water would be excessive, because each claimant would be seeking for all he could secure. It would mean a division of a great resource among a few people, under which they could tax all who come in the future. There is only one just and effective way to establish titles to water, as there is only one just and effective way to manage public land. This is to place it under public supervision and to have the conditions under which rights can be acquired clearly defined, and require every intending user of water to conform strictly to these requirements and observe all the limitations imposed. The need of safeguarding the water supply grows out of the fact that no other resource has so vital a relation to future development and is so necessary to the life and comfort of every dweller in that region. Every drop of water taken from a stream is of interest to all the people who live in its valley. Every drop which enters the head of a canal or escapes from its banks is a matter of public concern. The vast areas which are watered from a single stream, the multitude of users which depend upon it, the complex interests which irrigation has created, all make it indispensable that rivers should be divided by public officials. Without this it is always the weakest who suffer. Agreed divisions are the opportunity of the selfish and strong. Without public protection farmers can not live in peace. Settlers scattered for scores and hundreds of miles along the river can not leave their farms to prevent the stream being robbed and water wasted by ditches above.

The appropriation for the irrigation investigations of this Office makes the study of laws affecting irrigation and riparian proprietors and institutions relating to irrigation the leading feature of its work, and rightly so. Its duties are wholly educational. The responsibility for legislation rests ultimately with the people themselves. The facts published have, however, already had much influence in arousing public sentiment to the need of reform. No effort has been spared to gather and report the facts with honesty, accuracy, and courage by

men of capacity and experience, each of whom has been left entirely untrammeled in presenting his views as to reforms needed. It is a matter of great significance that in the reports on California and Utah men working apart from each other have reached practically the same conclusions.

While the first object of the irrigation investigation of the Office is to gather the facts and present them in a form to be understood, the entire duty of those intrusted with their management is not discharged by doing this alone. Those who make these studies should be something more than mere reporters. Wherever the lesson of these facts seems to be clear, and wherever the demand for reforms is urgent, this should be stated. We are dealing with one of the most vital questions of the United States. The arid lands of the West are marvelously fertile; supplied with water they equal the best farming districts of the humid States in the range and value of their productions. The healthfulness of the climate, the scenic beauty of Western valleys, make it possible to create homes under irrigation which will possess a higher average of human comfort than can be found in many sections elsewhere. If these natural advantages are developed under wise laws and just policies, there is no question that the irrigated portions of the arid West will be densely populated by a contented and prosperous people. But this is only in case wise laws and just policies shall prevail. It will be otherwise if streams become the possession of monopolies and the tiller of the soil becomes a tenant of the owner of the water. It is not enough to secure material development in the West. What we should strive for is to have this development take place under laws and customs which shall reflect credit on a self-governing people. The irrigation codes of the arid West ought to be the equal of the water laws of any country in the world, and the civic pride of Western communities should be aroused to secure this result.

The reports of this Office have been written with this end in view: To point out the dangers which menace the future and which can not be evaded by ignoring their existence. Sooner or later they will press for solution, and this solution can be more easily reached before abuses have become hardened by time and custom to have all the force of law. The marvelous development which the past twenty-five years has witnessed has been due to the wealth of natural resources, but the haphazard diversion of streams which is possible when the water supply is abundant ought not to be longer continued. On every stream the amount of water available for irrigation and the amount required to irrigate an acre of land should be determined. Provision should be made for the location of works according to some systematic plan, both to secure the conservation of the water and the irrigation of the best lands. The future location of irrigation works should be under some sort of supervision and they should be limited to the available

water supply, both as a means of preventing controversy and as a protection to inexperienced investors. Every canal built in excess of the capacity of a stream means either the loss of money and time spent in its construction and in the improvement of the land under it, or the robbery of the settlers under some older ditch. There should be some agreement regarding the limitations which govern a water right. Until it is settled whether these rights are personal property to be shifted from one location or use to another at the will of the appropriator, or are rights of use only and limited to some definite location, there will always be controversy and litigation over the division of streams. The following quotation from a former report expresses a conviction which has not been changed:

> The only right to water which should be recognized in the arid land is the right of use, and even this must be restricted to beneficial and economic use in order that the water supply may serve the needs of the largest possible number of people. Ownership of water should not be vested in companies or individuals, but in the land itself. When this principle is adopted the control of water is divided precisely like the land, among a multitude of appropriators; water monopoly is impossible and no other abuse is fostered by it. Years of painful experience, both in this country and elsewhere, have abundantly proven that peaceful and orderly development can not be realized except as land and water are forever united in one ownership.

Thus far all water rights have been established under State laws, and wherever streams are being administered this work is being done by State officials. The national irrigation act perpetuates State control by recognizing the supremacy of State laws in the establishment of titles to water. This is the correct economic policy. President Roosevelt, in his message for 1901, outlined the duties and responsibilities of the nation and the several States when he said:

> The benefits which have followed the unaided development of the past justify the nation's aid and cooperation in the more difficult and important work yet to be accomplished. Laws so vitally affecting homes as those which control the water supply will only be effective when they have the sanction of the irrigators; reforms can only be final and satisfactory when they come through the enlightenment of the people most concerned. The larger development which national aid insures should, however, awaken in every arid State the determination to make its irrigation system equal in justice and effectiveness that of any country in the civilized world.

The settlement of interstate questions will probably require national legislation, but within the States a larger measure of public supervision will be necessary in the future than has been found desirable in the past. These laws should include:

(1) A determination of the priority and amount of all existing rights.

(2) The division of States into districts based on drainage lines and the creation of an authentic record of the priorities and amounts of appropriations of water in each of these districts.

(3) The protection of rights to water in times of scarcity by the division of streams among appropriators by some public official.

(4) Limitation of all rights to use and the attachment of rights for irrigation to the land irrigated.

(5) The establishment of some systematic and orderly procedure for the record of all future appropriations, and the prompt establishment of priorities and amounts of rights acquired through beneficial use.

IRRIGATION IN THE HUMID SECTIONS OF THE UNITED STATES.

There are few sections in the United States where at some time during the growing season a drought of greater or less severity is not experienced each year, and where the application of water, if for a brief period only, would not secure largely increased yields. It remains to be determined, however, whether this kind of irrigation will pay. The answer to this question is of enough importance to the agriculture of the country to warrant the aid of this investigation. The number of farmers who are establishing experimental irrigation plants is already large, and the advice given by this Department during the last season affected the expenditure of several hundred thousand dollars. It prevented some serious mistakes, which would have cost more money than was appropriated for the investigation. Without this advice nearly all of the pumping plants installed would have had too small a capacity and the result would have been a loss of the investment and of the farmer's time and an erroneous conclusion as to the value of irrigation. In addition to this general assistance, systematic studies of the possibilities of irrigation in the humid portions of the United States are now being carried on in Wisconsin, Missouri, and New Jersey in cooperation with the State agricultural experiment stations of those States. The results in 1901 were all in favor of irrigation because the season was dry. The results in 1902 were less favorable because the season was wet.

IRRIGATION IN NEW JERSEY.

The report of Prof. Edward B. Voorhees, director of the New Jersey Agricultural Experiment Station, who has charge of investigations in New Jersey, reaffirms his previous statement that an irrigation plant will pay in connection with trucking and fruit growing and will be of service every year for one or more crops. His investigations have shown that irrigation on a small scale is entirely practicable and profitable, with plants costing from $150 to $600 and capable of irrigating from 1 to 10 acres. So far as the section dealt with by Professor Voorhees is concerned, it is practically settled that in intensive farming irrigation is profitable. The problem which still remains to be studied is whether it is practicable to utilize water by gravity systems in those districts where the soil is poor, but well adapted to sweet potatoes, small fruits, and other vegetable crops. In sections of New Jersey

there is sufficient water, and it can be brought to the land in gravity canals if the loss from seepage in the open, porous soils does not prevent. The problem, therefore, is not one of application to crops, but of the difficulties of distribution, and these matters are now being studied.

If it shall prove that gravity irrigation is profitable, there will still remain the question of whether water can be legally diverted from these streams without conflicting with the rights of riparian proprietors or those using the water supply for power purposes. The first question to be determined, however, is whether or not irrigation will pay, and the evidence, so far as gravity systems are concerned, is not as yet conclusive.

IRRIGATION IN WISCONSIN.

The sandy lands around Stevens Point, Wis., were chosen for the beginning of the investigations in that State, the purpose being to determine what effect irrigation would have on the sandy soils, which without an additional water supply have little agricultural value. The investigations of 1901 were explained in the report of last year. The soil here contains so little clay that water can not be carried through open ditches. Last year a canvas hose was used in distribution, but was not satisfactory, and was replaced this season by a 10-inch main of sewer pipe, the canvas hose being used for distribution from this main. The rainfall this season was unusually heavy, being 1.59 inches in April, 8.88 inches in May, 3.16 inches in June, 4.04 inches in July, 1.82 inches in August, or a total of 19.49 inches for five months. Nevertheless, most of the crops were irrigated once or twice during the latter part of the growing period. Because of the leachy character of the soil, the heavy rainfall of May was not retained, and irrigation under these conditions gave an increased yield. The water for the lands irrigated is raised by a gasoline pumping engine, the lift being 33 feet. The following were the results:

Early potatoes were irrigated once, on August 8. The water used covered the land to a depth of a little over an inch; 3.44 gallons of gasoline were used in pumping the water for each acre, the expense being $0.43 for fuel, $0.25 for preparing the ground, $0.15 for applying the water, or a total cost of $0.83 an acre. The irrigated acres yielded 93 bushels per acre, the unirrigated 81, or a gain for irrigation of 12 bushels. On unmanured land the irrigated acres yielded 63 bushels, the unirrigated 58, or a gain of 5 bushels to the acre. Late potatoes were watered twice, the water used covering the ground to a depth of 4.07 inches. The expense for fuel was $1.73 an acre; for applying the water, $0.67; preparing the land, $0.25; or a total cost of $2.65 an acre. On manured land the increase was 17 bushels per acre; on unmanured land, 6 bushels per acre. The potatoes were

sold at $0.20 a bushel, so that on the manured crops there was a profit and on the unmanured ones a loss.

Tomatoes were irrigated at a profit of $5.69 an acre. Strawberries were also irrigated, but owing to washing of the soil through the rows and the rapid leaching of the water the results were unsatisfactory.

Prior to the receipt of the report of this year's investigations, it had been decided that the experiment at Stevens Point should not be continued, because of a belief that the same expenditure in other localities and along different lines will give results of more general value. As has been before stated, the fundamental question in the East is whether or not irrigation will pay, and in order to answer this the first study should be made in the growing of high-priced products on productive land, where it is most likely to be beneficial. The cost of preparing to irrigate does not justify irrigation experiments on land which has little value. The best results will most likely be had where the value of the crop is great, and where an increased and certain yield is important. Irrigation of rice in Louisiana pays, hence the work in Louisiana has been devoted to the problems of rice irrigation. The conditions which attend cranberry growing in Wisconsin seem to be analogous to those which attend the growing of rice in Louisiana, and arrangements are being made to spend all the funds available on a study of the irrigation of cranberries. This industry has been struggling with many difficulties, and its ultimate success still depends on the solution of many problems. It has been demonstrated that the conditions are favorable for this fruit, but progress has been marked by great waste in private and ill-directed experimenting. In one case an attempt was made to warm the marsh by two 25-horsepower boilers. These now lie rusting in the field. Again, parties tried to pump water for 40 acres of marsh with an 8-foot windmill. The greatest loss has, however, been through litigation. Cranberry growers stand in need of more definite information as to the amount and character of water needed, the influence of temperature of water on the fruit, and the effect on the ground-water level produced by the drainage of adjacent areas. It is the intention to cooperate with the State Agricultural Experiment Station of Wisconsin in the study of these questions.

IRRIGATION IN MISSOURI.

The investigations in Missouri have been under the immediate supervision of Prof. H. J. Waters, director of the Missouri Agricultural Experiment Station. A storage reservoir has been built to furnish water, which will be used chiefly in the irrigation of fruit trees and vines, and in stimulating the growth of nursery stock. The results indicate that such irrigation will pay. The orchard and small fruits watered during the drought of 1901 gave largely increased yields in 1902, showing that the effect of irrigation is not limited to the year

the water is applied. Professor Waters believes that in Missouri an expenditure of $200 an acre can be profitably made for the purpose of irrigating nursery stock.

IRRIGATION IN THE SOUTH.

It is in the South, however, that the greatest progress is being made in the installation of small irrigation plants, and it is here that the conditions promise the most satisfactory results. During the past season this Office has furnished advice as to the installation of pumping plants by farmers, and there are a number of requests on file for this kind of assistance in the spring of 1903. Farmers engaged in truck farming in the vicinity of Atlanta, Ga., and Birmingham, Ala., are manifesting much interest in this question, and the work being done in that section warrants the insertion of a letter, giving the results of one season's operation of one of the first plants installed in that part of the South under the direction of this Office.

ROME, GA., *November 29, 1902.*

ELWOOD MEAD, Esq.,
Washington, D. C.

DEAR SIR: Your valued favor of the 20th instant, asking that I send you a statement covering my experience with irrigation during the past season, is to hand.

I take pleasure in giving you the facts, although my experiments so far have been of a very limited character.

My farm lies in a horseshoe bend of the Coosa River, some 30 miles southwest of Rome, in Cherokee County, Ala.; a body of land about 2 miles long and $1\frac{1}{4}$ miles in width; generally level, with some slight undulation. The land is thoroughly ditched for drainage, having some 5,000 rods of drainage ditches. The banks are high, and not generally subject to overflow. No crops of any character have ever been lost by reason of high water. The land is generally a heavy loam soil, retaining moisture well, and for many years has produced heavy crops of grain and clover.

For the past five years our section has suffered from severe summer droughts, and protracted dry spells during the fall season, with the result that our clover crops have failed us entirely; a good seeding and catch in the fall or spring, fading away either under the summer drought or extreme dry fall.

My corn crops have also seriously failed during the last several years.

Under this condition, after considerable reading and study of the irrigation problem, I sought the assistance of your department. You were kind enough to send to my place, in March last, Mr. W. H. Code, an engineer and irrigation expert, connected with your department.

Under his plans and advice I have erected an irrigation plant, putting in an 8-inch "centrifugal horizontal pump," 10-inch suction, 8-inch discharge, 2,000 gallons capacity per minute. This pump is geared to be driven by a 35-horsepower engine, with a 40-horsepower boiler. The lift from low-water mark is 30 feet 6 inches to top of high bank, where the water is discharged into a canal, and taken by ditches to the different fields.

The completion of my plant was delayed, and our first water obtained on the evening of July 25.

The past season has been one of unprecedented drought, no seasonable rain having fallen upon my farm from after the first week in April until September. However, for the purpose of making an experiment, my manager had planted a field of corn

early in June. On July 25 much of this corn was not over 4 to 8 inches in height, bleached almost white and apparently dying. On the evening of July 25 and succeeding day, the 26th, this field was irrigated by the furrow and in considerable part flooded with an abundant supply of water. Twenty-one days later I rode through this field of corn and on a good sized horse was unable to reach the top of the stalks, which were growing vigorously and of a rich dark color. That corn has been harvested and estimated to make no less than 50 to 60 bushels per acre.

Irrigation was also tried upon a field of moderately early corn, which during July had reached the tasseling and earing stage. This field of corn was suffering severely for water; the tassels bleached and the corn in "twist." After 4 to 6 hours the stalks gave decided evidence of reviving and in a short while vigorous growth and heavy earing was noted from this field, and a good crop of corn and heavy yield of fodder have been harvested. Some portions of this field not irrigated have made only indifferent nubbins. Other fields near by have been cut down for forage only, no ears appearing upon the stalks.

On a field of peas, some 35 acres, two irrigations were given during August with the result that a heavy growth of both vine and pods was had. Fields near by without irrigation were hardly worth mowing, and no pods or peas made.

The young corn first referred to, first irrigated July 26, was again irrigated in the course of three weeks, in August. Good showers in September brought this corn to maturity.

I am unable to give you exact and scientific data as to how much water was used nor did we keep exact dates other than as noted above.

My plant was completed so late in the season that my superintendent and farmer had despaired of any results; he is now enthusiastic and full of hope for the future.

I do not reside on the place and have but little opportunity of giving personal direction, but with the practical results obtained I have planned to care for 400 acres with my irrigation plant during the coming year.

The fields irrigated lie uniformly, with easy grade. A competent farm engineer handled the plant, and two men distributed the water. A run of twenty-four hours was made, with the consumption of less than 4 cords of good oak wood. The cost of fuel and labor would differ according to locality and special conditions. My wood was cut upon my place, my own teams hauled it, and men were employed by the year.

With a full season and opportunity another year I hope to be able to make more accurate tests and demonstration of the value of irrigation.

I may add that for the first time in my planting experience and knowledge, my full oat crop, after reaching a fine growth of straw, failed to make a seed from the absolute want of moisture. Had I been prepared to give one good irrigation to this field of oats, in the early part of May last, the yield would have practically paid for the installation of my plant.

Very truly, yours, HAMILTON YANCEY.

RICE IRRIGATION.

The remarkable increase in the production of rice along the Gulf coast has made it desirable that the irrigation problems of this section be systematically studied. Many of the farmers know nothing of the methods of applying water to crops. Many unsolved questions confront the manufacturers of pumping machinery and those who buy and operate it. There is need to know how much water is required, how it can be distributed with the least loss, and used to the best advantage. In addition, the drought of 1901, which continued unrelieved throughout the season of 1902, has shown the need of an early deter-

mination of how much water the streams of this section can be relied upon to supply, and the enactment of some laws for the establishment of rights to this supply and for their protection in times of scarcity. Otherwise there is danger that this development will continue beyond safe limits. During the past season so much water was pumped from the bayous and streams that in some instances the current was reversed. There was not enough fresh water coming in from above, and the shortage was made up by salt water flowing inland from the Gulf. The use of brackish water caused the injury of many crops, and some were destroyed. If this is to continue, a permanent injury to the soil will be the result. The agents of this Office gathered samples of this water, which were shipped to the Bureau of Chemistry for analysis, and prompt warning was given to companies that the water was becoming too salty for safe use.

The need of supplementing the water supply of bayous and streams led to giving special attention to irrigation from deep wells, and the report for 1902 will contain valuable records of the cost of such wells, the volume of water furnished by them, the cost of pumping machinery, and its operation. A comparison of these records with the value of the crops raised is needed to show the limits of this development.

During the past season but little was done in the study of irrigation in the rice fields along the Atlantic. That irrigation is destined to be extended in this section is shown by the use now being made of it in market gardening, and a number of pumping plants were installed for the irrigation of ordinary farm crops under the advice and direction of the agents of this Office. The drought which prevailed made this an unusually favorable season for such experiments, and all the results thus far reported have been favorable.

IRRIGATION IN THE INSULAR POSSESSIONS.

During the past year Mr. Jared G. Smith, in charge of the agricultural experiment station in the Hawaiian Islands, made an investigation and prepared a report of some of the results of irrigation on the sugar plantations of these islands. This will be published in the report of irrigation investigations for 1902. The outlay per acre for the water supply on these sugar plantations is probably greater than in any other part of the world. On the island of Oahu the cost for pumping plant alone on the Oahu plantation is $143.63 an acre. On the Ewa plantation, on the same island, it has been $172.85 an acre. The cost of supplying water last year on the latter plantation was $35.72 per acre. The average lift on one plantation is 452 feet, and water is lifted in some instances 650 feet. Professor Smith's report gives the details of some of these pumping plants.

Some correspondence has been had with the governor of Porto Rico relative to a study of the water-right questions of that island, and it is

hoped to send an agent there for that purpose during the ensuing year. Prof. Frank D. Gardner, in charge of the agricultural experiment station in Porto Rico, has submitted a memorandum of the irrigation problems of that island, from which the following is quoted:

On the south side the rainfall is much less and the periods of drought are more regular and of much longer duration, and in order to grow sugar cane, bananas, and some of the minor crops successfully, irrigation is imperative. The irrigated area of the south side aggregates approximately 25,000 acres, nearly all of which is in cane. During seasons of prolonged drought the water supply is inadequate to irrigate all the land now under cultivation, and there is a demand for increasing this supply by storage reservoirs or by driven wells, either of which, it seems to me, may be successfully practiced. Many of the canals are of masonry, although some of them are of earth. They are usually very substantial in character, as well as very durable. The quality of the water is very good, it usually being clear and always containing very little mineral matter. When the supply of water is short, I am told there is a good deal of trouble between planters regarding their water rights, and I am unable to state if there are laws regulating water rights in Porto Rico. A firm engaged in the growing of sugar cane at Aguirre have recently sunk a large number of driven wells and connected them so that they can use a large engine in pumping, and in this way supply irrigation water for a considerable area of land.

It seems to me that it would be very desirable to investigate the laws of Porto Rico relating to irrigation; also the feasibility of increasing the water supply.

PUBLICATIONS.

The irrigation publications of the past year included 4 technical bulletins, 1 farmers' bulletin, 1 Yearbook article, and an account of the irrigation investigations during 1901 for the report of the Director of this Office.

Bulletin No. 108.—Irrigation Practice Among Fruit Growers on the Pacific Coast. By E. J. Wickson, M. A., Professor of Agricultural Practice, University of California, and Horticulturist of the California Agricultural Experiment Station. Pp. 54, pls. 10, figs. 7. Price 15 cents.

This bulletin gives the results of a special investigation into the conditions, extent, and methods of irrigation as practiced among fruit growers on the Pacific coast.

Bulletin No. 113.—Irrigation of Rice in the United States. By Frank Bond and George H. Keeney, Agents and Experts, Irrigation Investigations, under the direction of Elwood Mead, Chief of Irrigation Investigations. Pp. 77, pls. 28, figs. 10. Price 30 cents.

In this bulletin Mr. Bond describes the rice industry of Louisiana and Texas, and gives measurements of the quantities of water used in irrigating rice. The laws relating to irrigation of the two States dealt with are also discussed. Mr. Keeney's report covers North Carolina, South Carolina, and Georgia, and is almost wholly descriptive.

Bulletin No. 118.—Irrigation from Big Thompson River. By John E. Field, Assistant State Engineer of Colorado. Pp. 75, pls. 5, fig. 1. Price 10 cents.

This is a study of the water laws of Colorado as illustrated by the irrigation from Big Thompson River. Mr. Field discusses more particularly the "water loaning" law, a recent enactment which has a tendency to unsettle all existing rights to Colorado streams.

Bulletin No. 119.—Report of Irrigation Investigations for 1901, under the direction of Elwood Mead, Chief of Irrigation Investigations. Containing summary of results by R. P. Teele and Reports by W. M. Reed, W. H. Code, A. J. McClatchie, E. W. Hilgard, W. Irving, A. E. Chandler, O. L. Waller, D. W. Ross, Samuel Fortier, A. P. Stover, O. V. P. Stout, H. J. Waters, F. H. King, E. B. Voorhees, and J. C. Nagle. Pp. 413, pls. 64, figs. 12. Price 50 cents.

This is the third of the annual reports of the irrigation investigations of this Office. It deals chiefly with the duty of water, but contains also reports from four stations in the humid States, where irrigation is not a necessity, but a means of increasing the returns from farm lands; a report on the underground water supply of the San Bernardino Valley, California, and the second progress report on silt measurements.

Farmers' Bulletin No. 158.—How to Build Small Irrigation Ditches. By C. T. Johnston and J. D. Stannard, Assistants in Irrigation Investigations, Office of Experiment Stations. Pp. 28, figs. 9.

This is a reprint of an article in the Yearbook of the Department of Agriculture for 1900, entitled "Practical Irrigation" (see below), giving methods for laying out and building small irrigating ditches, using only such implements as are found on most farms or can easily be made by the farmer.

Some Typical Reservoirs in the Rocky Mountain States.—By Elwood Mead, Irrigation Expert, in Charge of Irrigation Investigations, Office of Experiment Stations. Pp. iv, 415–430, pls. 8. (Reprint from Yearbook, 1901.)

This article describes some of the typical reservoirs of Colorado and Utah, paying especial attention to cost of construction and returns from the use of the stored water.

The Scope and Purpose of the Investigations of the Office of Experiment Stations.—By Elwood Mead, Chief of Irrigation Investigations. Pp. iv, 417–436, pls. 4. (Reprint from Annual Report of Office of Experiment Stations, 1901.)

DIETARY STUDIES OF GROUPS, ESPECIALLY IN PUBLIC INSTITUTIONS.

By C. F. Langworthy, *Food and Nutrition Expert.*

INTRODUCTION.

Reasonable economy in diet is an important matter in the household of a large proportion of American families. By this is not meant that the family must live for the lowest possible sum, but that the diet should be satisfactory in proportion to its cost, and that undue waste should be avoided, while at the same time the daily fare is wholesome, attractive, and adequate. When large numbers are to be fed under uniform conditions, economy in the purchase and preparation of food and the avoidance of waste in the planning of a diet become of even greater importance than in the family. The saving of a few cents per person per day or per week may not materially affect the expenditure in a family of 4, but the matter assumes very different proportions in the case of 400 or 4,000 persons.

The circumstances under which large numbers are fed under more or less uniform conditions are varied. In some instances the diet calls for the expenditure of public money and in others of private funds.

The Army and Navy furnish examples of a large body of men fed with funds provided by the General Government. Different State and municipal governments maintain hospitals, sanitariums, homes for incurables, foundling asylums, orphan asylums, insane hospitals, industrial schools, almshouses, prisons, houses of detention, jails, and other charitable, reformatory, and penal institutions. Schools, colleges, and universities are in a sense public institutions and, indeed, are often supported by State appropriations. Generally speaking, however, the diet of students is not provided with public funds. The Government Military Academy at West Point and the Naval Academy at Annapolis are instances of schools supported by the Government in all respects. In most large towns there are charitable organizations which differ in some respects from any of those mentioned, such as homes for the aged and infirm, which are supported by donations and endowments. Another group, different in many respects from those mentioned, is furnished by convents, monasteries, and similar religious institutions. As examples of large groups of an entirely different

character, fed under uniform conditions by private enterprise, may be cited the patrons of large hotels and boarding houses, especially those designed for employees in factories, mines, lumber camps, etc. This division of the subject should also include the groups provided for in provisioning ships, camps, and expeditions.

The total number of individuals in the United States who may be fairly included in the different groups enumerated above must be very large, though an estimate of the number would be difficult to make. The Army and Navy constitute a large proportion of the total number, and the same may be said of students in schools and universities. The number maintained wholly or partly at public expense in institutions under public control is also large. Generally speaking, of the persons fed in penal and benevolent institutions in the United States one-third are in jails, reformatories, and kindred institutions; one-fourth are inmates of almshouses, one-fourth are found in hospitals for the insane, and the remainder are in benevolent institutions and hospitals. This division does not take into account the large number of persons supported by charitable, religious, and similar organizations maintained by private funds. While statistics of the subject as a whole are not available, some idea of its magnitude may be gathered from the fact that in the State of New York alone upward of 100,000 persons of the dependent and delinquent classes are housed, clothed, and fed in the public institutions of the State at a cost of about $26,000,000 per year. From 20 to 29 per cent of this sum is expended for food. Assuming that 23 per cent represents the average, the annual cost of food would not be far from $6,000,000.

It is obvious that in all lines of work general principles must be understood and a considerable amount of information must be available before special questions can be satisfactorily considered, especially with reference to their bearing upon the general subject. This is as true of dietetics as of physics or chemistry. During recent years there has been a large amount of experimental inquiry regarding the food and nutrition of man. Activity in such lines of research has been especially marked in this country during the last fifteen years. A large part of this inquiry has been conducted, under authority of Congress, by the Department of Agriculture in cooperation with universities, colleges, technical schools, experiment stations, and charitable organizations in different parts of the United States, though extensive and important contributions have come from investigations carried on at universities and medical colleges, and from other sources.

As a result of such investigations there are to-day available about 5,000 analyses of American food materials, and thus it seems fair to say that the composition of the greater number of the common food materials is fairly well known. Some 400 studies of the actual food

consumption of families or groups have also been made, including in all about 2,000 persons in families and boarding houses and 30,000 in penal institutions and insane asylums. This material furnishes fairly accurate information regarding the actual dietary habits of a large number of persons living under very different conditions as regards income, occupation, etc. The results of some 400 digestion experiments, for the most part made with men, furnish a fairly satisfactory basis for judging of the relative proportions of the nutrients and energy of different food materials which the average person can utilize as food passes through the body.

The above statements refer only to American investigations. It should be remembered that the work in other countries along these lines is also extensive and that the results are valuable for comparison and use in other ways. Mention should also be made of the still more abstract researches with the respiration apparatus in Europe and the respiration calorimeter in the United States. The latter investigation was carried on with the Atwater-Rosa respiration calorimeter at Wesleyan University, Middletown, Conn., under the direction of Prof. W. O. Atwater, who, as chief of the nutrition investigations undertaken for the Department of Agriculture by this Office, has had general charge of the cooperative investigations frequently referred to in this article. The investigation, up to the present time, has included some 50 experiments with men, covering about 150 experimental days, during which an accurate account has been kept of the income and outgo of matter and energy under different conditions of diet and varying degrees of mental and physical activity. These experiments, especially those conducted with the respiration calorimeter, serve to show more accurately than perhaps any other form of experimenting the amount of nutrients and energy which the body requires under different circumstances, the ways in which they are used, and the comparative nutritive values of different food materials.

As a result of the extended inquiries in this country and elsewhere the general principles of nutrition are fairly well understood to-day, and it is possible to apply the results of experiments and experience in providing the diet of public institutions. It is now possible to study rationally in public institutions, such as prisons, hospitals, and orphanages, the kind and amount of food supplied, as well as its cost, and to learn the physiological demands of the inmates, thus securing data for comparing dietary conditions in a given institution with other institutions and with commonly accepted dietary standards. The economy of the food supply as compared with its cost and the needs of the persons nourished can also be tested. Judging from past experience, the knowledge thus obtained will frequently show where and how improvements may be made in the purchasing, storing, cook-

ing, and serving of the food, which will render the diet more attractive and palatable and, if necessary, better balanced and more nutritious, while at the same time the cost may be frequently reduced.

The claim is not made that it is impossible to provide a proper diet for an individual or a group without taking into account the results of dietary studies and similar investigations. In this, as in all cases, practical experience, as handed down through countless generations, has shown that diet must be made up of wholesome food products, and has shown in a general way the amounts required and the desirable combinations. However, it is reasonable to claim that in conducting any enterprise the results of actual investigation can be more depended upon to give uniform and satisfactory results than rule of thumb. The proper feeding of individuals and groups is no exception to the general rule.

GENERAL PRINCIPLES TO BE OBSERVED IN PROVIDING A PROPER DIET FOR INSTITUTIONS AND GROUPS.

From the great number of facts learned by experience and general observation, and in a larger measure from the numerous experimental investigations which have been carried on, some general deductions can be drawn regarding the satisfactory feeding of large groups under uniform conditions. In planning a suitable dietary for a group or institution, or in efforts to improve the dietary schedule already in use, the following principles should be considered: (1) A certain amount of food is necessary for the maintenance of the body. (2) This food requirement, technically called the physiological demand, differs with different conditions of age, sex, health, muscular activity, environment, etc. (3) For convenience, dietary standards expressing the physiological demand are measured, not in quantities of food materials, as meat, bread, potatoes, and other foods, but in quantities of nutrients and energy, since the food value of all materials may be uniformly expressed in these terms. (4) It is practically impossible to store, cook, and serve food without some shrinkage and waste, the quantity of food thus lost depending very largely upon its quality and upon the methods of storeroom, kitchen, and dining room management. (5) To adequately meet the needs of a group or an institution, the food supply must be enough to cover not only the physiological need of all who are fed, but also the actual shrinkage and waste. (6) If more food is supplied than is necessary, the kitchen and table wastes are likely to be increased, and there will also be a tendency to consume more food than is required to maintain good physical condition, thus entailing still further pecuniary loss, to say nothing of the unnecessary tax upon the digestive system and the consequent injury to health. On the other hand, if the food supply is

too limited and the shrinkage and waste are large, there is a danger of underfeeding, which is more to be avoided than its opposite. (7) Pecuniary economy requires not only that there shall be a minimum of shrinkage and waste, but that the food shall be such as to furnish the needed nutriment at the lowest cost consistent with the comfort and well being of the persons fed. (8) Hygienic economy requires not only that the food shall meet the physiological demand in respect to the quantities of nutrients and energy, but also that it shall be fitted to the digestive powers and other physiological peculiarities of the users. This is of special importance with the aged and infirm and with invalids and young children. (9) The comfort and welfare of the users are promoted by making the food palatable and attractive, and should always receive due consideration.

SPECIAL INVESTIGATIONS REGARDING DIET OF INSTITUTIONS AND GROUPS.

In what has just been said the investigations dealing with the general subject of nutrition have been referred to, and a number of conclusions cited which are based upon such general work. The number of investigations which have been made in connection with special problems concerning the diet of institutions and groups is also large, and much has been learned which is of value.

THE ARMY AND NAVY.

Long ago the fact was recognized by all civilized countries that the diet of the Army and Navy must be provided on a judicious basis, and, as a result, regulations governing the army diet in times of peace and war have been devised, and special rations are provided for special conditions, the whole subject being handled with the idea of providing, at a reasonable expenditure, food which is suited to maintain the men in health and supply them with an abundance of energy for the demands made upon their physical strength and endurance. In planning army rations, the general principles of nutrition are made use of as well as data which have accumulated regarding the composition of food, the energy expended in different kinds of work, etc. The special investigations which have been carried on with soldiers with a view to learning their special food requirements, the best methods of preserving food, the relation of food to health, the relative amount of muscular work involved in different kinds of marching, drilling, etc., are very numerous.

A few years ago Meinert, in a large volume, summarized the investigations which had been made with special reference to the feeding of armies.[a] In a later publication the same author discussed the sub-

[a] Armee- und Volksernährung, vol. 1. Die Neueste Ernährungstheorie und deren praktische Verwerthung bei der Ernährung der Armee. Berlin, 1880.

ject in connection with the problem of feeding large numbers or groups.[a] Meinert has compiled data showing the nutritive value and cost of the daily ration of the German, Austrian, French, Italian, Belgian, Dutch, Swiss, Spanish, Russian, Turkish, English, and United States armies, giving, in a number of instances, both the peace and war rations. He also discusses at length specially prepared foods, condensed foods, and similar products in relation to the rational and convenient feeding of soldiers. In 1880 a special commission reported on the subject of army diet to the Bavarian Government,[b] and collected much valuable information. In 1889 a committee appointed by the British Government issued their report on the diet of soldiers.[c] Very recently Zuntz and Schumburg[d] have reported on an extended series of investigations which were undertaken to determine the energy expended in route marching. It is obvious that this problem is closely connected with feeding soldiers, since the measurement of the energy expended is one of the best guides for judging the kind and amount of nutrients which the ration should furnish. Numerous other special investigations might be cited.

It has been very often said that there is undoubtedly much truth in the assertion that the German troops owed their success in the Franco-Prussian war quite largely to their fine commissariat. Care had been taken in advance to provide the soldiers with a suitable diet, and especially with highly nutritious condensed foods; for instance, the so-called pea sausages, which furnish a large amount of nutritive material in small bulk and can be readily prepared.

The investigations which have been carried on in Russia in connection with the study of various problems relating to the feeding of soldiers and sailors are many. A few illustrations will suffice to show something of their character and scope. Punine[e] studied the influence of horseback riding, which is a special form of muscular exertion, upon the assimilation of food and the metabolism of nitrogen. Passover[f] made a special study on the effects of another form of muscular work, namely, rowing. Chakalev[g] studied the comparative value, as shown by digestibility, of a number of sorts of preserved vegetables designed for use in making up the army rations. Smetski[h] studied

[a] Massenernährung. Berlin, 1885.

[b] Ernährung des Soldaten im Frieden und im Krieg. Munich, 1880.

[c] Great Britain. Report of the committee appointed to inquire into the question of soldiers' dietary. London, 1889.

[d] Studien zu einer Physiologie des Marsches. Berlin, 1901.

[e] The influence of horseback riding on the metabolism and assimilation of nitrogen in healthy men [Russian]. Inaug. Diss., St. Petersburg, 1894.

[f] Influence of rowing on the health of the common soldier, and the work of rowing [Russian]. Inaug. Diss., St. Petersburg, 1893.

[g] Digestibility of preserved vegetables designed for soldiers [Russian]. Inaug. Diss., St. Petersburg, 1886.

[h] The composition of salt meat and assimilation of its nitrogenous constituents [Russian]. Inaug. Diss., St. Petersburg, 1886.

the composition and digestibility of the salt meat furnished the Russian navy. Dietary studies and digestion experiments have been made and other related topics have been studied, as well as the question of diet in relation to disease and similar problems.

Numerous studies of diet as a whole and of special foods for soldiers have also been carried on in France and other European countries. One of the problems which has been very thoroughly investigated, in connection with the French army, has to do with the comparative value of different sorts of fresh and preserved meat from the standpoint of both nutritive value and economy.

As is well known, the Japanese are very ready to adopt, in all things, measures which have proved to be valuable. It is not surprising to find, therefore, that they have devoted much attention to investigations concerning the diet of the army and navy. It will be recalled that the disease beriberi, which is very prevalent in the East, is attributed to the use of an excessive rice diet, though the specific cause is not known. Extended investigations were undertaken in the Japanese navy by a committee appointed by the Government, one of the most active members being Surgeon-General Takagi, with a view to learning the relation between diet and this disease.[a] It was found that when the amount of animal food was increased and barley replaced a part of the rice the ravages of beriberi were checked. Later bread replaced rice with the same result. Other instances might be cited in which the Japanese have made practical use of results obtained in special nutrition investigations.

In general it may be said that the problem of properly feeding the Army and Navy has for many years received the attention it deserves, and that all civilized nations make an attempt to do this in accordance with well-established principles of nutrition. The United States is not behind other nations in this respect, and the use which was made in this connection of the results of the American nutrition investigations was one of the earliest proofs of their practical utility. The ration of the American soldier is made up of a comparatively small number of suitable articles of diet, provision being made for the purchase of fresh meat and vegetables in accordance with regulations which are flexible enough to suit different conditions. Furthermore, there is provision for exchanging certain components of the ration for articles not regularly issued or for increased amounts of those which are regarded as especially palatable. Compared with the rations issued to other armies it seems fair to say that the American soldiers' food is very superior in quality, quantity, and variety. That it is suited to the needs of the men is shown by their fine physical condition, maintained under ordinary conditions and during active service.

The statements which have been made in relation to the diet of the

[a] Kaigun Kakkebyo Yobo Jireki, 1890.

Army apply with equal force to that of the American Navy. Providing a fit diet for men on shipboard necessarily presents special problems, since dependence must be placed more generally upon stores transported with the troops than is the case with land forces. The attention which is paid to details in relation to the U. S. Army diet is shown by such works as How to Feed an Army,[a] Manual for the Subsistence Department,[b] Manual for Army Cooks,[c] and many others.

A similar volume published recently by the Navy Department is entitled "The General Mess Manual and Cookbook,"[d] and contains detailed directions for providing, cooking, and seasoning the rations of the sailors of the U. S. Navy.

From time to time special investigations have been undertaken in connection with the office of the Commissary-General of the Army and by others connected with the Army and Navy. As an illustration may be cited the study of the practical value of the use of an emergency ration, made up of condensed foods, by troops on active service recently conducted by Dr. C. Smart.[e]

EDUCATIONAL INSTITUTIONS.

Many dietary studies have been made at schools, universities, and other educational institutions, but since the conditions in the different investigations have been far from uniform the material is hardly sufficient in amount for general deductions. However, enough has been accomplished to show the importance of the work, and in individual instances it has been possible to make suggestions for improving the diet materially without increasing its cost or for decreasing the cost without affecting its nutritive value and attractiveness. A considerable proportion of the dietary studies with students have been made in Germany and Russia. The number of Japanese investigations is also fairly large. Such studies have also been reported in England, Ireland, Italy, and other European countries, and also from Bengal. It seems obvious from the extent of the work that such investigations have been regarded as of importance and value. Some idea of the variety of the problems studied may be gathered from the few examples following, which were selected from a very large number: Uspenski[f] made a special study of the dinners served at the student restaurants in Kiev. Rosadski[g] investigated the dietary of the students living in the dormi-

[a] War Department, Document No. 129, Subsistence Department.

[b] War Department, Document No. 21, Subsistence Department.

[c] War Department, Document No. 18, Office Commissary-General of Subsistence.

[d] U. S. Navy Department, 1902.

[e] Rpt. Com. Gen. Subsist., U. S. Army, 1897, pp. 12–19.

[f] Journal of the Russian Society for Preserving the Health of the People [Russian], 1897, pp. 122, 141.

[g] Food of the pupils living in the dormitory of the first Kiev gymnasium [Russia], Kiev, 1896.

tories of the first Kiev gymnasium. Tawara[a] studied the diet of the pupils in a Government school in Tokio and at a private school in the same city. Serafini[b] has made a special study of the dietary habits of Italian university students, particularly those of the University of Padua. The kinds and amounts of food consumed by the students of the Bengal Institute was studied by F. Raymond.[c]

In connection with the nutrition investigations of this Department, some 15 dietary studies have been made of clubs of men and women students in different educational institutions in widely separate regions. Dietary studies and other investigations have also been made with college athletes. These investigations have, like others carried on by the Department, been reported in special bulletins.[d] The results obtained have been of use in discussing dietary standards and in other similar ways, and have also in a number of instances been of considerable assistance in suggesting improvements of the diet in quality and quantity. A number of dietary studies with students clubs and college athletes have been carried on by the Connecticut (Storrs) Experiment Station, some of them in cooperation with this Department. The results are reported in the station publications.[e] A study of the food consumed and digested by four members of the Harvard University boat crew was recently reported by Prof. W. O. Atwater and Dr. F. G. Benedict.[f] Dietary studies of students have been reported from time to time by other American investigators. For instance, Mrs. Ellen H. Richards and Miss Marion Talbot,[g] in an investigation regarding food and its effect upon student life, report dietary studies of women students at the University of Chicago. Similar studies of men and women students' clubs, carried on at the Western Reserve University, have been reported by Tower.[h] A few years ago a dietary study was made at the Lyman School,[i] of Worcester, Mass. The greater number of the group there studied consisted of young boys. A series of studies was lately made of the dietarias of ten students at Randall Hall, Harvard University, by Mr. Edward Mallinckrodt, jr., with the cooperation of Prof. C. R. Sanger, the results of which await publication by this Department.

As previously stated, investigations like those just spoken of have proved useful for solving a number of problems, in determining diet-

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[a] Arch. Hyg., 1888, p. 102.

[b] Arch. Hyg., 29 (1897), p. 141.

[c] Ann. Rpt. Civ. Vet. Dept. [Bengal], 1897–98, Append. 21–22, pp. 14–16.

[d] U. S. Dept. Agr., Office of Experiment Stations Buls 21, 29, 31, 37, 53, 75, 84, and 91.

[e] Connecticut (Storrs) Station Rpts. 1891, 1893, 1894, and 1895.

[f] Boston Med. and Surg. Jour., 144 (1901), pp. 601, 629.

[g] Food as a Factor in Student Life. Chicago, the University of Chicago Press, 1894.

[h] Western Reserve University, n. ser., 4, 1901, p. 146.

[i] Sixteenth Annual Rpt. Trustees State Primary and Reform Schools [Massachusetts], p. 25.

ary standards, and in similar ways. Perhaps it is not going too far to claim that it is owing in a large part to these and similar investigations that so much interest has been aroused in the diet of school children, especially the providing of suitable lunches. This is believed to be a subject of such importance from the standpoint of the children's health that no large school building in towns where children must carry lunches should be without some provision for supplying warm and wholesome lunches to pupils who wish to purchase them. Serving meals at noon to school children was practiced in foreign countries for some time before it was tried in the United States. Large schools in England, like that of Manchester, have for years provided a noon meal. In Vienna the children are served a meal by the People's Kitchen for a very small sum. In Paris the municipal government provides a lunch which is sold to the children. It seems that Boston was the first of the American cities to attempt to provide suitable lunches in a systematic way in the school buildings, so far as can be learned the first work of this kind being carried on at the Boston Normal School of Cookery.

The interest in providing suitable diet for students is not confined to schools. Many of the large universities have adopted plans for providing suitable food for students, under such supervision that a satisfactory and wholesome diet is issued. Memorial Hall at Harvard is an illustration of such an institution. Considerable data regarding student diet at Harvard is furnished in an article by R. W. Greeleaf,[a] and similar articles relating to other institutions have been published from time to time.

One of the most interesting practical applications of the nutrition investigations is furnished by the dietary of college athletic teams. In all large universities this is managed with great care, and very frequently is under the charge of a physician, who has had special training in nutrition, or is in the hands of some other competent person.

CAMPS AND EXPEDITIONS.

Very few detailed studies have been reported on the provisioning of camps and expeditions. Books of travel and similar publications contain more or less data on the subject which apparently have never been collected, summarized, and discussed from the standpoint of dietetics. The character of this information may, perhaps, be fairly judged from the statements regarding food and diet made by Nansen[b] in the account of his famous polar expedition. Spurr[c] recently reported estimates for a diet suited to expeditions in Alaska on the basis of the food requirement per man per month.

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[a] Harvard Graduates' Magazine, vol. 2, 1893–94, p. 171.

[b] Farthest North. New York, 1897, vols. 1, 2.

[c] Geol. Survey Rpt., 20 (1898–9), pp. 44, 45.

In the provisioning of camps and expeditions it is frequently true that dependence must be placed entirely upon foods transported with the expedition. Hunting and fishing may furnish some additions to the diet, but the amount of such material can not, of course, be correctly estimated beforehand, and it is essential that an adequate food supply should be provided for in advance. The general problem has been much simplified in recent times by the manufacture of a large number of evaporated, canned, and preserved foods which will keep for an almost indefinite time in good condition in all climates. This makes it possible to provide easily a much more varied, as well as wholesome, diet than was once the case. Many condensed foods and so-called emergency rations have also been prepared for use in expeditions as well as in the Army with the intention of supplying a diet with sufficient nutritive value and very small bulk. Condensation by evaporation and pressure are the principal means resorted to for securing small bulk. Such foods have been analyzed and tested in various ways, the literature of the subject being too extended to refer to at length here.

The general subject of provisioning camps and expeditions was discussed in a publication of the Royal Geographical Society of England,[a] first issued in 1854, which has since appeared in many editions; the equipment of exploring expeditions was also treated of by M. Walton Brown,[b] and the general subject has been recently discussed at considerable length by C. H. Snow,[c] a special feature of his article being a description of a number of evaporated and condensed foods, and suggestions for using such materials to prepare a properly balanced diet.

BOARDING HOUSES, HOTELS, AND SHIPS.

Dietary studies have been made in large boarding houses for factory operatives, miners, lumbermen, etc., but the total number is not large compared with similar studies made in families. A number of these investigations were made in Russia, Germany, Belgium, and Japan. A recent publication by J. Orpen,[d] is of special interest, since it deals with the diet of the native laborers, especially miners in South Africa, a subject on which hitherto very little reliable information has apparently been published. Dietary studies are not reported, but the most common articles of diet are described, as well as methods of preparation; dietary habits are discussed, and suggestions are made for improving the diet. One of the points noted by the author is

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[a] Hints to Travelers. See especially chapter on "Outfitting."

[b] Transactions Institution Mining Engineers New Castle [Great Britain], 15 (1897–8), p. 443.

[c] Transactions American Institute Mining Engineers, 29 (1899), p. 157.

[d] The Diet of Native Laborers: Argus Printing and Publishing Company, Limited, Salisbury, Rhodesia, 1902.

worth mentioning, since it is of general application, namely, that in order to be satisfactory a diet must be provided which conforms to local dietary habits, the fact being also recognized that the food must be adequate in amount and of a wholesome character.

In the United States a number of dietary studies have been made in boarding houses of factory operatives, bricklayers, lumbermen, etc. In 1886 Prof. W. O. Atwater, in connection with the Massachusetts bureau of statistics of labor, began such studies in boarding houses in several cities in Massachusetts. The work was extended to the French provinces of Canada, owing to the fact that a considerable proportion of the persons included in the earlier studies were French Canadians. The work was continued in cooperation with the United States Bureau of Labor, and yielded interesting and valuable results. Under Professor Atwater's direction similar studies were made in New England of bricklayers and others performing severe work. The general deduction from the series of investigations, of which the above are a part, was that the American workmen are more abundantly nourished than similar persons in Europe. The results obtained were of much use in fixing upon dietary standards, for purposes of comparison, and especially of advantage in determining the effect of muscular work upon food requirements. Cooperating with this Department the Maine Experiment Station has recently carried on dietary studies in the boarding houses of winter lumber camps in the Maine woods. The results await publication.

The provisioning of large hotels, it seems fair to say, has been reduced to a very practical and efficient system. The same is true of the provisioning of the ocean steamships and other vessels. Methods naturally differ with individual stewards and purchasing agents, but as a whole the subject has been carefully considered and is necessarily conducted on a business basis. It does not appear that this branch of the general subject of nutrition has ever been studied with a view to learning the amount of nutrients provided per person or the average cost of the daily diet under different conditions, nor has the mass of information which must exist on this subject been collected and made available for the uses of students of nutrition. It can not well be doubted that such a compilation would be of great interest.

HOSPITALS, SANITARIUMS, AND SIMILAR INSTITUTIONS.

The subject of hospital dietaries and the proper feeding of those who are ill or convalescent has been studied perhaps more than any branch of the general subject of dietetics. The work has been largely and quite naturally carried on in connection with other investigations pertaining to the practice of medicine. It is, however, so closely connected with the nutrition of normal man in health that no sharp line

can be drawn between the two kinds of research. So much has been accomplished that most well-managed hospitals make the attempt to provide general diets suited to different classes of patients, as well as special diets for special cases. The information now available regarding the food requirements in certain diseases and the salutary effect of proper diet in their treatment is surprisingly large compared with what was known only a few years ago; nevertheless, much information is still needed in this as in other lines of research. In the case of hospitals a regulated diet is manifestly important, since the selection of suitable foods is a great help in the treatment of the sick and the recovery of the convalescent. As an illustration of the attempts made to reduce hospital diet to a system may be mentioned the work of Prausnitz,[a] which was carried on at Munich several years ago. In his opinion hospital inmates may be divided into three groups as regards food requirements, as follows: (1) Those who have some disease which does not affect their appetite, (2) those recovering from fevers and similar diseases, and (3) those patients whose disease or general condition demands a special diet. The first he believes should have a diet equal to that of ordinary persons, the second class a diet as abundant as they can endure, and the third a diet suited to individual needs, which must be determined by the physician in charge. Prausnitz recognized that in all cases the foods and methods of preparing different dishes should correspond to the usual dietary habits of the patients.

Other ways of arranging hospital diet have of course been devised. The literature of the subject is very large, a great number of articles on such topics having appeared in medical journals and similar publications.

The proper diet for sanitariums, homes for convalescents, homes for incurables, and similar institutions is a subject closely related to the foregoing. It does not appear that any considerable number of dietary studies have been made in such institutions, though some few investigations have been carried on which have to do with special questions connected with the general subject. It is obvious that the food requirements must vary in different institutions and must very frequently be regulated for certain patients by the physicians having them in charge. As was the case with hospital dietaries, the literature of the subject is to be found largely in medical journals and reports. In all institutions where the sick and convalescent are cared for it is well recognized that the diet should be suitable, appetizing, and as attractive as possible. Often the cost is an item which must be considered, and in such cases care and skill in preparation will often produce as satisfactory dishes from inexpensive materials as can be prepared with less care from those which are more costly.

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[a] Vierteljahresschrift für Oeffentliche Gesundheitspflege, 25 (1893), p. 563.

PENAL AND REFORMATORY INSTITUTIONS.

The literature relating to dietaries of prisons, houses of correction, and other reformatory and penal institutions is extended. In earlier times the food of the inmates of such institutions was frequently very poor and inadequate, but most civilized communities now recognize the fact that poor diet is not a proper punitive measure and that the inmates of penal and reformatory institutions should be supplied with a diet suited to their physical needs, which will, of course, vary as in all other cases with the amount of bodily work performed and similar conditions. Very frequently the reports of prisons and like institutions contain more or less detailed statements regarding the kind and amount of food furnished to the inmates. As an illustration may be cited statements regarding the Milbank Prison dietary,[a] published in 1822. In a discussion of this subject mention should be made of the extended investigations by John Stanton Gould[b] of the food of almshouses, prisons, and hospitals, which were begun about 1850 at the instance of the commissioners of education and board of governors of the New York almshouse department. In his report the food requirements of inmates of different kinds of institutions, the preparation of food, and related topics are discussed and detailed statements are made regarding the kinds and amounts of food consumed at a number of institutions in New York City, Philadelphia, Pa., Baltimore, Md., Washington, D. C., Boston, Mass., and elsewhere. In regard to the data recorded and the use which is made of it these investigations are directly comparable with more recent dietary studies. As was the custom at the time, the author discusses the nutritive value of the diet on a basis of the nitrogen and carbon supplied by it rather than on the basis of protein and energy. The data recorded are abundant and it would be a simple matter to recalculate the dietaries in accordance with the custom now followed.

Among more recent investigations may be mentioned that carried on in 1896 by Mrs. Ellen H. Richards and Miss Sarah E. Wentworth, who were requested by the institutions' commissioner of Boston to investigate the food supplied by the public institutions in that city. These included houses of correction and reform, almshouses and hospitals, and similar institutions. The results obtained, showing the amounts of nutrients and energy supplied per person per day, were based upon the quantities of raw materials purchased during a given period and the average composition of similar materials. Certain modifications were suggested in the rations to replace those in actual use. These were based upon the probable physiological demands of the different classes of inmates, with a margin allowance for waste,

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[a] American Prison Discipline. First Annual Report, 1822, p. 14, cited by Gould.

[b] Report on Food and Diet Suited for Almshouses, Prisons, and Hospitals. New York, 1852.

amounting to 10 per cent of the protein and about 7.5 per cent of the fat.

Quite recently at the New York State Reformatory at Elmira an investigation was undertaken to determine the influence of diet as a corrective measure. The investigations were not extended enough for definite deductions. Such studies should be continued at reformatory institutions, as any measure which promises to be of assistance in bringing about the desired reformation of character is certainly worthy of careful study.

As an outgrowth of the investigations conducted under the auspices of this Department, dietary studies were made by the State authorities at the Elmira Reformatory under the supervision of Prof. W. O. Atwater, the results of which await publication.

The amount of investigation which has been carried on in Europe in connection with diet of prisons, almshouses, and other charitable, reformatory, and penal institutions is very extended. Some years ago Voit[a] discussed the subject at considerable length and made a number of suggestions for the providing of a satisfactory diet for such institutions. Shortly afterwards Meinert[b] discussed the same subject and compiled a large amount of information regarding the diet in prisons, hospitals, insane asylums, homes for the aged, poorhouses, and peoples' kitchens. Krohne and Lehmann[c] more recently published investigations on the diet of prisoners, as have many other investigators in Germany, Russia, and other European countries. Considerable work along this line has also been carried on in Japan. The method and results of some of these inquiries are illustrated by Dr. J. C. Dunlop's investigation, which was carried on among the Scotch prisons in 1898 and 1899 at the request of the prison commissioners for Scotland. He was instructed to report concerning the dietaries in use and to suggest desirable improvements. After a careful study of the rations actually consumed by the different classes of prisoners, he suggested certain changes, based upon what he considered the physiological demands of the inmates. Some of these suggestions were tested by actual trials with selected prisoners; and as the results seemed entirely satisfactory, the suggestions were adopted. The improved rations were based not only upon differences in the amount of labor performed by different classes of the population of penal institutions, but upon differences in sex, body weight, age, and climatic conditions. They apparently include little or no allowance for waste, and therefore represent very nearly the estimates of physiological demands.

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[a] Deutschen Vierteljahrs für öffentliche Gesundheit, 8 (1876), p. 7.

[b] Armee- und Volksernährung, vol. 2, Die Kost in staatlichen und kommunalen Anstalten, die Volksküchenkost und die Kost der arbeitenden Klassen. Berlin, 1880.

[c] Neue Versuche über Gefangenernährung, Berl. Klin. Wchnschr., 1890, p. 30.

HOMES FOR THE AGED, ALMSHOUSES, AND OTHER CHARITABLE INSTITUTIONS.

As was said above, the diet in homes for the aged has been a subject of some investigation. It is obvious that the food requirements of aged persons, who are probably capable of performing only a limited amount of muscular work, must be different from that of younger and more robust individuals. Such institutions have been maintained for many years in Europe and the United States. German institutions, guided by the results of dietary studies, have long endeavored to provide a suitable and adequate dietary for the inmates. According to a recently published account[a] special homes are provided in Denmark for maintaining the respectable aged poor at public expense, the funds being provided in part by the municipal and in part by the General Government. These institutions are different from almshouses, and are designed to provide comfortable homes for those who have always led respectable lives and who, through no fault of their own, are unable to provide for themselves late in life. The food in these homes is a matter which has received much attention and is, perhaps, worth mentioning in detail, as it illustrates a principle which, as previously mentioned, should always be taken into account in such cases, namely, that the diet should be prepared in accordance with local food habits. The foods selected and the dishes prepared are such as are believed to be suitable in consistency and other respects to the needs of aged persons, and at the same time the diet is adequate, while the methods of cooking and serving are such as the inmates would follow in their own homes. The cost is low, the care of the inmates of these institutions averaging only about 25 cents per person per day in cities and towns and a little less in the country, a very moderate sum in comparison with that expended in the care of inmates of institutions in other countries, and the more remarkable in view of the fact that the homes provided are said to be very comfortable. At the Copenhagan home an interesting system is in force by which the inmates prepare a part of their meals. In the morning a cup of hot milk is brought to each person, and at 11 and 3 o'clock they are expected to make their own coffee. Twice a week butter, cheese, and bread are issued to all, and these foods are taken to their rooms and eaten with the milk and coffee, or whenever desired. Dinner and supper are served to all in the usual way, much attention being paid to the attractiveness of the diet.

These Danish homes are in many respects comparable with those maintained in many large towns of the United States for aged persons. American institutions are almost always supported by private gifts or

[a] Living Age [Littell], 7. ser., 17 (1902), No. 3046, pp. 473–483, from The Nineteenth Century and After.

endowments. So far as can be learned no dietary studies have been made in these institutions, although such investigations would be of much interest and value, especially as the amount of data regarding the actual food requirements in old age is limited.

The direct opposites of the institutions just mentioned, at least in the point of age of the inmates, are foundling asylums, orphan asylums, and other charitable institutions for children. The literature of the general subject of nutrition contains a number of references to dietary studies and other similar investigations which have been carried on in such institutions, the greater part of this work having apparently been undertaken in Germany. So far as can be learned no attempt has been made to collect this literature. Undoubtedly such a summary would be useful in fixing upon dietary standards for children of different ages, and in other ways. It is obvious that the food requirements of children are not the same as those of adults, a considerable proportion of food being required for growth and the development of the body during infancy and childhood, as well as for maintenance.

In all communities there are a larger or smaller number of persons who must be maintained at public expense in almshouses and similar institutions. A number of investigations have been made, especially in Europe, with a view to determining the best and most economical diet for the inmates of such institutions. It is generally agreed that the food supply should be palatable, wholesome, and reasonably attractive, although it is usually necessary to keep the cost moderate. The investigations referred to have frequently shown that a marked improvement in quantity or quality or both was possible without additional cost, and other important improvements demanded by special cases have been suggested. As noted above, Voit and Meinert have paid special attention to the proper diet for almshouses and such institutions. European literature contains many other reports on the subject. One of the most interesting of these was published in 1866 by Dr. E. Smith,[a] regarding the diets of the inmates of a large number of English workhouses, the investigation having been undertaken at the request of the president of the English poor law board. In addition to information regarding the condition of the inmates in these institutions, Dr. Smith reports statistics of the kind and amount of the food eaten and its composition and discusses the methods of preparation and related topics. In considering the diet special emphasis is laid on the fact that the food requirements of children and adults, men and women, young persons and aged persons are not the same, and that the diet, to be satisfactory, should differ in accordance with the requirements as dependent upon age, sex, and occupation. The composition

[a] Dietaries for the Inmates of Workhouses Reported to the Poor Law Board, London, 1866.

of the diet is not expressed in the same terms as are generally used at the present time, but the data are so full that such values could be readily recalculated. Some of the principles laid down by the author for guidance in planning institutional dietaries are quoted below, as they have an interest not limited to the time at which they were made or the institutions for which they were originally proposed:

The foods to be selected shall be those in ordinary use, and shall constitute such a mixed dietary of animal and vegetable products as is commonly met with in the dietaries of the working classes and as has been found needful to maintain health.

The aim shall be to obtain the largest amount of nutriment at the least cost, having due regard to the digestibility of the foods and the tastes of the people to be fed. * * *

The food to be supplied to infants under nine months of age should be milk alone, and throughout childhood and youth the quantity of food should be abundant so as to maintain growth.

Able-bodied adults should be fed upon a sufficient quantity of bread and the coarser kinds of food.

The aged and infirm should have food easy of digestion and also certain luxuries which are indeed now regarded almost universally as necessaries by laborers' families at their own homes.

Suckling women should have abundant food.

The sick should be dieted under the direction of the medical officer, but certain general diets should be prepared. * * *

As no class of the community takes the same rotation of foods week by week and month by month, it is advisable that the rotation in workhouses should be changed at intervals, say of a month, so that the same day shall not always be associated with the same kind of food.

The need of potatoes and fresh vegetables is also pointed out, the author noting that the amount used should depend upon the cost at any given time. At the period these studies were made the excessive use of salt meat was a great evil in the dietaries of almshouses and similar institutions. Dr. Smith protests against the excessive use of such food and urges the need of fresh meat when it can be obtained. The importance of his work was evidently appreciated by the British Government, which has continued to supervise the diet of such institutions and from time to time has issued reports on some phases of the subject.

NUTRITION INVESTIGATIONS IN HOSPITALS FOR THE INSANE.

In comparison with the total number of dietary studies which have been made in families, the number of such investigations made in insane asylums is comparatively small. In comparison with some of the groups included in this discussion, however, the number is fairly large. The principal investigations made in institutions for the insane, which have been found in journals, reports, etc., are referred to below. It is probable that many others are included in the reports of such institutions and in the proceedings of conventions of asylum directors

and related literature. So far as can be learned no compilation of such data and statistics has ever been made, though it would undoubtedly prove of great value.

Some twenty-five years ago Beneke[a] noted a dietary study of an English lunatic asylum. Several years later Nötel[b] reported data showing the nutrients in the dietary of nine Swiss institutions for the insane. Similar data were reported by Von Gellhorn[c] for three German institutions. The results of these dietaries are quoted and discussed at some length by Meinert.[d] Dr. Nötel called attention to the fact that the diet of the insane should furnish an abundant quantity of digestible nutrients. In his opinion the food requirements are the same as those for normal individuals at light work, except in special cases where the mental condition of the patient demands some special diet. Von Gellhorn in the institution at Uckermünde supplied a diet to male patients of the second class, furnishing 122.4 grams protein, 71 grams fat, and 475 grams carbohydrates. This diet was regarded as abundant and care was taken that it might also be palatable. It is stated that after this diet was introduced the total death rate diminished from 8.6 in 1876 to 5.6 per cent in 1878 and 1879. Von Gellhorn in discussing these results says in effect that even if one regards the proverb: "As a man eats, so he thinks," as too general, most would agree that the functions of the brain can be influenced by the nourishment supplied the body. Remembering, too, that energy is supplied by food, it is fair to conclude, he thinks, that diet constitutes a remedial agent which should be taken into account in caring for the insane. In view of the facts and figures quoted Meinert believes that the daily diet of the insane should correspond to Voit's standard and supply on an average 118 grams of protein, of which at least 100 should be digestible, and 56 grams of fat in addition to 500 grams carbohydrates.

Within the past year an extended study of the diet of pauper lunatics in Scotland was reported by J. C. Dunlop,[e] the investigations having been made under government auspices for the general board of commissioners in lunacy for Scotland. In this report details are included of the diet in 23 asylums and of the lunatic wards of 14 poorhouses. The author judges the value of the diet by the energy which it supplies rather than by the protein, believing that this is the more satisfactory method, since he thinks that the amount of protein

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[a] Zur Ernährungslehre des Menchen, 1878, p. 287.

[b] Armee- und Volksernährung, vol. 2. Die Kost in staatlichen und kommunalen Anstalten, die Volksküchenkost und die Kost der arbeiten Klassen, Meinert, p. 63.

[c] Ibid., p. 64.

[d] Ibid., pp. 59–64.

[e] Report on dieting of pauper lunatics in asylums and lunatic wards of poorhouses in Scotland. Supplement to the Forty-third Annual Report of the General Board of Commissioners in Lunacy for Scotland. Glasgow, 1902.

required can not be regarded as definitely known. Until more data are available he believes that 118 grams of protein should be supplied daily to men, and four-fifths of that amount, namely, 94 grams, to women. He believes that the average asylum diet for men should furnish 3,300 calories, that of male working patients 3,500 calories, and that of comparatively idle male patients 3,100 calories, and that the corresponding diets for women should furnish 2,650, 2,800, and 2,500 calories. The average of all the male dietaries examined by Dunlop showed 3,335 calories, which is approximately the value called for by his proposed standard, while the average of female dietaries was 2,890 calories, or 9 per cent larger than the proposed standard. In 11 cases the energy value of the diet of the male patients was excessive as judged by the standard; in 15 cases it was deficient, and in 13 cases it approximated the standard. In 25 cases the diet of females was excessive, in 3 cases deficient, and 8 cases approximated the standard. In making these investigations account was taken of the weight of the patients, and it is stated that "the weight test has with a few exceptions given results which corroborate the result of the comparison of the actual food value with the standard food value." In the discussion of the results special stress is laid on the fact that the patients should be classified according to their food requirements on the basis of sex and work performed. The importance of variety in the diet is urged, and a number of detailed suggestions are made for guidance in the preparing of a proper diet for pauper lunatics.

In addition to dietary studies the following digestion and metabolism experiments with the insane may be mentioned: E. Grabe[a] studied the digestive power of the insane, especially digestion in the stomach. Tuczek[b] in 1883 and 1884 studied the effect of fasting on the metabolism of nitrogen with two patients in the Marburg Insane Asylum. Doubtless other digestion and metabolism experiments have been recorded, but an extended search of the literature indicates that such experiments are by no means numerous.

The earliest dietary investigation in an asylum for the insane in the United States which has been found is that of the Boston Lunatic Asylum, included in J. S. Gould's[c] report on the food and diet suited for almshouses, prisons, and hospitals mentioned above. Little more is included in the publication mentioned than the bill of fare, and the work is of interest chiefly from an historical standpoint. The most extended inquiry regarding the diet in institutions for the insane and methods for improving the dietaries and dietetic management of such institutions which has been thus far made in the United States, and perhaps in any country, is that instituted by the New York commission in

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[a] Ueber bei Verdauungsthätigkeit der Magens bei Geisteskranken. Dorpat, 1891.
[b] Arch. Psych., 15 (1885), p. 798.
[c] Loc. cit., p. 80.

lunacy among the hospitals for the insane in that State. This enterprise was placed in charge of Prof. W. O. Atwater and carried on for some four years, the results having been printed in the reports of the commission for 1897–98, 1898–99, 1899–1900, and 1900–1901. The primary object of the inquiry was to establish a proper dietary standard, based, in so far as possible, upon the physiological needs of the hospital population. Other purposes were to study ways in which losses of food by shrinkage and waste in the storeroom, kitchen, and dining room might be reduced; to render the prescribed ration more flexible and at times more economical by suggesting ways in which one food material may be replaced by another without changing the nutritive value of the diet; to devise methods, if practicable, by which more palatable dishes may be prepared without increased cost, or equally attractive dishes at less cost; and, finally, to see how the diet in general may be best adapted to the health and comfort of both patients and employees. In carrying out the inquiry two considerations, the welfare of the people in the hospital and the interests of the taxpayers, at whose expense they are supported, have been kept in mind.

The plan was to study the statistics of food supply in the hospitals; to find by weighings and measurements how much food is actually eaten by the different classes of the population; to examine into the methods of selection, handling, cooking, and serving the food; to make chemical analyses, when necessary, in order to learn the composition and nutritive values of the food materials; to employ skilled experts to examine into the best methods of cooking and of kitchen and dining-room management; to devise experiments upon the proper feeding of patients of different classes; and, finally, to learn how the proper officers and employees, and especially the chefs and cooks, may be best enabled and encouraged, not only to carry out, but also to devise methods for improvement. More or less was done in all these directions. The accounts of the inquiry, results, and conclusions are given in three reports, filling in all nearly 1,500 pages.

As the result of 56 dietary studies in the New York hospitals for the insane it was found that, taking the inmates as a whole, the food actually eaten furnished, on the average, not far from 75 grams of protein and 2,300 calories of energy per person per day. The averages for the food of different classes ranged from 48 grams of protein and 1,600 calories of energy for women of the "infirm" class, and 64 grams of protein and 2,170 calories of energy for men of the same class, to 53 grams of protein and 1,870 calories of energy for the "restless, active, disturbed" women, and 95 grams of protein and 2,840 calories of energy for the workingmen. The inquiry was not regarded as extended enough to warrant the fixing of definite physiological standards for the different classes of patients in the asylums or for the inmates as a whole. Before such a standard could be exact, feeding

experiments and other investigations are necessary. While these would not be numerous they would require considerable time and would probably prove expensive, yet they would many times repay their cost. The work already accomplished, however, furnished so much information that it seemed that a tentative physiological standard was warranted. That proposed for the whole number of inmates was 85 grams of protein and 2,450 calories of energy per person per day. This, it will be observed, was 13 per cent larger in protein and 4 per cent larger in energy than the actual food consumption. It is not intended to imply by this that the people did not eat enough. Indeed, their appearance and general physical condition showed that there was no reason for assuming that they were in any way underfed, but the experiments were not carried far enough to absolutely demonstrate that a larger food ration than that actually consumed might not in some cases have been better; so, in proposing a standard, which it is recognized may not be exact, it seemed best to err on the side of liberality. It will be noted that the proposed standard calls for less protein and energy than Nötel and Dunlop believe desirable. It seems probable, however, that in their investigations no account was made of waste and that the values proposed by them included the food furnished rather than the nutrients eaten. The values in the dietary studies carried on in the New York hospitals refer to quantities eaten, and, as already noted, the proposed American standard provides much more than the patients were found to consume on an average. In view of this fact it seems fair to regard it as sufficiently liberal.

The appetite, it is often assumed, may be taken as a measure of the food required, but in many cases it is a very unreliable guide. Excessive eating is not only a waste of food and, therefore, of money, but it can hardly fail to be injurious to health. In the opinion of well-informed physicians and hygienists, a large proportion of the people in comfortable circumstances in this country eat more than is necessary, and this opinion is certainly borne out by figures showing the actual food consumption. On the other hand, there are many people who, on account of poverty, from lack of appetite, or for some other reason, do not eat as much as would be best for them. The above statements apply to people of sound mind, and perhaps in still greater degree to those who are not normal mentally. It is frequently necessary in feeding the insane to regulate the amount of food allowed individuals, as otherwise some patients would eat more and others less than was required. In regulating the amounts served, the so-called dietary standards should always be kept in mind. These are commonly based upon the estimated physiological demands of persons of different age, sex, and occupation, and especially of different degrees of muscular activity. These estimates are in turn commonly based upon what has been found to be the actual food consumption as shown by (1) studies

of dietaries and (2) by feeding experiments. Although much attention has been given to this subject, both in this country and in Europe, the available data are not yet sufficient to make the values agreed upon as accurate as is desirable. Some of the data of most use in fixing upon dietary standards comes from experiments in which the income of the body in terms of food constituents is compared with the outgo in the products excreted by the intestines, kidneys, lungs, and skin. By making such experiments with a number of different persons under different conditions, and taking into account, with other things, the food eaten, the kind and amount of work done, and the gain or loss of body material, it is possible to learn more or less exactly what the body actually needs and what is used for its nourishment. The most valuable and at the same time the most difficult and costly experiments of this nature are those made with the respiration calorimeter, which, in addition to permitting the measurement of the income and outgo of matter and energy, shows the amounts of nutrients and energy actually required under different conditions and the value of different kinds of food and food combinations for meeting these requirements. This line of research has been developed by Professor Atwater and his associates in connection with the nutrition investigations of this Office.

The commonly accepted American dietary standards for persons under ordinary conditions as regards mental and physical health and environment were proposed by Professor Atwater and are based upon the large amount of experimental inquiry carried on both in Europe and the United States, much of the American research along these lines having been conducted in connection with the nutrition investigations of this Department. They are not proposed as final, but are regarded as tentative and subject to revision should this be found necessary as information accumulates.

The standard for a normal man in health, engaged in rather active muscular work, calls for 125 grams of total or 115 grams of digestible protein and 3,400 calories of available energy in the daily food. As compared with a man under such conditions, the relative amounts demanded by persons of different sex and varying degrees of muscular activity have been estimated as follows: Man with hard, muscular work 1.2 times; man with light to moderate work 0.9; man with sedentary occupation or woman with moderately active work 0.8; man with very little exercise or woman with light to moderate work 0.72, and a woman with very little exercise 0.64 of the amounts required by a man at rather active, muscular work.

These so-called standards have been sometimes more or less misunderstood. As explained by Professor Atwater, they do not by any means claim to be exact measures of physiological demands of different persons or of average persons of the several classes. They simply

represent the best information at present available and must be revised as more extensive and exact data accumulate. On the basis just stated the tentative standard for an average man at light to moderate muscular work would be 112 grams total protein and 3,160 calories of available energy per day, while with less exercise smaller amounts of nutrients and energy would be called for.

Few of the inmates of asylums engage in any considerable amount of muscular work and, as will be noted, the proposed standard for asylum dietaries calls for very nearly the same amounts as the proposed standard for a man with little exercise, namely, 90 grams of total protein, of which 72 grams are digestible, and 2,450 calories of energy. With our present knowledge of the subject this seems the fairest basis for estimating the actual food requirements of those who live under abnormal conditions and whose bodily functions, either physical or mental, are deranged or enfeebled. They may actually require more than similar persons under normal conditions or they may require less. Concerning this matter systematic research is much needed.

Several investigators, as noted above, have studied the actual food consumption of inmates of prisons and hospitals for the insane to see whether their condition improves, grows worse, or remains the same on given diets. What has been learned is not sufficient in amount to warrant general deductions, although the investigations have in nearly every case made it possible to suggest improvements in the diet of the institutions studied. The apparent differences in the estimates which different investigators make of the amounts of food required by the inmates of asylums and institutions are doubtless due quite largely to the paucity of the available data on this subject.

The actual food purchased in asylums and similar public institutions should be based upon the physiological demands of the inmates in so far as this can be determined, and with such marginal allowance as is necessary to cover shrinkage and waste. The extent of this marginal allowance will depend upon a variety of circumstances and even under the most favorable conditions it will usually be considerable. Judging by what has been learned in the studies already carried on, it may in some cases amount to as much as 33 per cent, though a smaller amount seems more reasonable.

In the New York hospitals the nutrients and energy in the food eaten at the outset of the inquiry were only about two-thirds of the amount in the food purchased. This implies that one-third of the actual nutriment of the food was of no value to the patient, and was utilized only in so far as the table and kitchen wastes were fed to pigs or other farm animals.

Judged by the usual standards, these institutions were well managed. The waste of food was no larger, it is believed, than is entirely natural unless specific attention is given to this particular subject.

As soon as the facts were known, steps were taken to reduce the waste, and a marked pecuniary saving resulted. What was needed was simply to have the actual facts pointed out, and the improvements followed naturally.

The annual cost of the food supplied to the New York State Hospital at the present time is about $1,125,000. Estimating the loss due to shrinkage and waste as one-fourth instead of one-third of this sum, it would amount to $281,000. A large part of this is unavoidable, but a saving of only 5 per cent in the whole cost of the food would amount to $56,000.

A careful watch kept in this direction will in many cases result in a considerable pecuniary saving. With unusual care in the selection and purchase of foods and with the aid of improved methods of handling and storing the margin for shrinkage should be reduced to a minimum.

In the work at the New York hospitals a definite effort was made toward improvements in kitchen and dining-room management, including especially the cooking. Experts were employed who were familiar with the requirements of such institutions, who were skilled in cookery, and who were well informed as to the general principles of nutrition and the nutritive values of different foods. They were able to devise dishes appropriate to the wants of the different classes of the hospital population, attractive both to the palate and to the eye, and at the same time economical as regards the materials used and the labor expended in their preparation. Some of these were "made over" dishes, and in addition to pleasing the palate and improving the quality of the diet they reduced its cost by the use of materials which would otherwise have been wasted or utilized only as food for farm animals. The influence of the experiments upon the chefs, the cooks, and the kitchen and dining-room management generally was regarded as most helpful.

Some of the advantages which, in the opinion of the New York State commission in lunacy, resulted from the nutrition investigations carried on in the State asylums may be gathered from the following statements, which are taken from an official summary:

As a result of this special work, we have now a definite idea of some of the good that has been accomplished, and we believe we are justified in expressing the following views:

First. The most important point has been the improvement in the food service, and this has been manifested in various ways. Under the stimulating influence of the work as conducted, the chefs and cooks have made a greater effort than ever before to prepare food in a more palatable form and in greater variety, with the effect of reducing the dining-room waste, as well as the kitchen waste, and thus making a saving in dollars and cents.

Second. We have found that economy results from using a larger variety of foods and foods that are better adapted to the various seasons of the year.

Third. With a knowledge of food values one can substitute various articles in the hospital dietary and thus promote economy. For instance, during the winter season, when eggs are expensive and sometimes poor, they can be omitted from the cooked dishes and at the same time skimmed milk from a creamery, when it is available, can be used in certain proportions in cooking.

Fourth. A comparative decrease in the cost of food has taken place, and this has not been due to the cutting down of food supplies, but rather as a result of care in utilizing every article that goes into the kitchen. One of the greatest savings came from the judicious use of left-over food. * * * We find that a comparison of food supplies as paid for in estimate No. 3 shows [in one of the hospitals] a yearly per capita reduction of $2.19, which, being multiplied by the average population for the year ending September 30, 1900, namely, 1,565.5, shows a total saving of $3,417. * * * This in spite of the fact that a great many articles of food were higher in price than they were during the preceding year.

At the Buffalo State Hospital for the Insane, according to Dr. A. W. Hurd, the superintendent of the institution, a number of changes were made as an outcome of the inquiries above referred to.

At the outset the attention of officers and employees was directed to the amount of waste, and also to the possibilities of improvement in some of the details of the cooking and serving of food. The books of the hospital showed a very material reduction in the per capita cost of the food after the investigations were undertaken. This saving, as based upon the per capita cost of the first year, is estimated by Dr. Hurd as 13.7 per cent. What makes this reduction in cost the more striking is the fact that it was effected notwithstanding a material advance in the price of a considerable number of the food materials, while at the same time the diet as a whole was improved. One feature has been the addition to the diet of the attendants of so-called "extras," which include fruit, hot breads, cold meats, etc.

Dr. Hurd, in speaking of the improved methods in the hospital, says that—

While we can not say that all this is due entirely to the food investigations, and while some of it is due to care and vigilance in buying, yet we think a great deal of it is attributable to the extra care and attention which have been paid to the cooking, distributing, service, and prevention of waste which are the outcome of the investigations.

Of the share of the hospital in the inquiry Dr. Hurd says:

The cooperation in this work has not been a burden or drag on the institution, but has, we think, resulted in a direct benefit to the dietary of the inmates, the satisfaction and contentment of all concerned, and has been a marked source of economy.

It should be remembered that the favorable results thus noted as a consequence of the nutrition investigations in the New York institutions represent only the first steps in an improvement. The changes for the better can be made not only permanent, but increasingly effective in proportion as governing boards, officers, and employees come to understand the underlying principles of nutrition, the ways in which they may be applied, and the meaning and usefulness of the results.

CONCLUSIONS.

The results of dietary investigations may be made particularly useful in fixing upon the proper diet for large groups or for the inmates of institutions in at least three directions which pertain to the physiological, the pecuniary, and the humanitarian aspects of the subject.

What has been said about the physiological need will suffice to show that the per capita demand for food in a group or institution will be influenced very largely by the character and amount of the muscular work performed. Soldiers and sailors with a fairly active life in times of peace, and still greater activity in times of war; students of sedentary habits, but performing a considerable amount of mental work; miners and lumbermen performing severe labor, often under unusual conditions of temperature or environment; the sick or convalescent inmates of hospitals; prisoners at hard labor; patients in hospitals for the insane, the aged, infirm, and other inmates of almshouses, and the children in orphanages and similar charitable institutions must have very different demands for nutrients. This means that the physiological standard which should serve as a basis for ration allowance in the different cases should be fitted to the specific demands of the class or particular group of individuals or to the institution considered. Actual dietary studies and feeding experiments, it seems fair to say, provide a most trustworthy way of learning what is the proper physiological standard. The proposed standards take into account what has been learned by such investigations, but more extended research is needed before the standards can be entirely satisfactory. To learn the ration allowance—that is, the food which should be supplied per capita for any given group or institution—it is necessary to add to the amounts representing the physiological demand a certain quantity to cover shrinkage and waste, which will vary in different cases. This, it is very evident, has a direct bearing on the financial side of the subject. It is recognized at the outset that more or less waste is unavoidable.

When the subject is carefully examined, it is surprising to see in how many ways waste may occur not only in institutions, but in private families. Even when there is no apparent carelessness in the management of the kitchen, storeroom, or dining room improvements may often be suggested. The small wastes are numerous and the sum total is often quite large. In households the amount of waste has been found to vary from practically nothing to as much as 8 or 10 per cent of the total food, being influenced by the management, the time of year, the class of foods purchased, the pecuniary necessities of the family, etc., while in boarding houses, even with ordinary economy, it has reached as high as 20 per cent in individual cases which have been observed. In feeding large groups and in public institutions the

tendency to waste is in some respects greater than in private families and small boarding houses, although on the other hand there is always the advantage which attends the purchase of large amounts. When large numbers are fed under uniform conditions it is frequently a more difficult matter to utilize left-over food than is the case in private families, owing to the lack in kitchen service and a quite common aversion under such circumstances to "made-over" dishes.

The necessary shrinkage in the storeroom, due to the large amount of food material which must be kept on hand, is always greater in institutions than in private families—vegetables decay, meats spoil, and in numerous other ways wastes occur, apparently not large in themselves but considerable as a whole. Often much of the waste is due to carelessness in the kitchen management. The equipment of the kitchen has also more or less to do with this phase of the problem, since the poorer the equipment the larger is likely to be the proportion of food which is wasted.

The reduction in the cost of the daily fare is not and should not be the chief object of dietary studies. Humanitarian considerations should be uppermost. This is a matter of especial importance in considering the diet in penal and reformatory institutions, hospitals for the insane, charitable institutions, etc.; in other words, under all circumstances where the persons fed have practically no voice in the management of their dietary. In prisons and reformatories it may be proper at times to make the diet one of the punitive agencies, but all prisoners do not require this, nor are all benefited by such means. Some can be reformed, and there are cases in which it is commonly believed that the diet may be used as an agency to this end by making it agreeable, and thus encouraging an effort to improve.

In such institutions as hospitals and almshouses the argument for palatable and attractive food is still stronger. Some of the inmates of hospitals for the insane may be cured, and whatever can be done to facilitate their cure is certainly desirable. Of the incurables a large number still have a keen appreciation of the comforts and discomforts of their situation. To do away so far as possible with their discomforts and to provide the things which contribute to their happiness is a plain duty. The same is true, perhaps in still greater degree, of patients in hospitals for the sick, of the aged, the infirm, and other unfortunates in almshouses, and the children who, in lack of parental care, are made the wards of the public.

The opportunities for dietary improvement are often great, and in some cases they are most urgently demanded, if the judgment of many of those who are familiar with the management of such institutions is to be accepted.

It is perhaps hardly necessary to say that the object of dietary studies and other similar investigations is not to unduly limit the amount

or variety of food supplied to institutions or individuals, but rather to discover ways and means by which their dietaries may be improved, if it is necessary, and to determine how the food supplied may be most economically used to maintain the body in good health.

Neither in the case of individuals nor institutions is it the purpose of food chemists to prescribe weighed amounts of different foods as a physician prescribes medicine, but rather to show the actual nutritive value of different food materials and their relative economy as sources of nutrients, and to endeavor to apply such knowledge to the securing of a better and more rational diet. Dietary standards, as previously noted, have been proposed for individuals of different ages and performing different amounts of muscular work. Based on these standards, others have been devised at different times for various institutions. It is not necessary, however, that the food each day should contain exactly the kind and amounts of the different nutrients indicated by the standards. A slight deficiency one day will be made good by an excess the next, the body serving as a storehouse for reserve material. Notwithstanding, experience has shown that the body is best nourished when, through long periods, the food approximates the requirements of the so-called standards. This is a matter of special importance in considering the diet of institutions, since the cost must be frequently moderate and there is thus a tendency toward underfeeding rather than overfeeding. Individual requirements and individual peculiarities will always affect the choice of foods when persons are at liberty to choose their own diet. This fact should be borne in mind when deciding upon the diet of institutions.

In the purchase of most articles their value for the purpose for which they are intended is considered as well as their cost. Without doubt the same principle may be advantageously applied to the purchase of food for individuals, for groups, and for institutions, by the exercise of a wise economy, based on the knowledge of the real nutritive value of foods and the requirements of the individuals fed. Experience has shown that in many cases a more satisfactory diet can frequently be obtained for a less sum than is at present expended, and the diet provided for a given sum can often be materially improved.

In this connection it may be observed that improvements in the diet of institutions, when needed, must be gradual, and of necessity must require long-continued experiment and observation. Methods of experimenting and the practical application of the results can be gradually developed in the institutions themselves, so that their own officers and employees will be able to accomplish the desired object in the most economical, useful, and satisfactory ways.

The foregoing discussion shows that in many foreign countries and in this country investigations undertaken to solve different problems in connection with the feeding of large numbers in institutions or else-

where have furnished results of great value. That such work is continued in Great Britain, Germany, Japan, and other countries, under government auspices is a proof that the experimental inquiry has justified the time and money expended upon it.

In connection with its nutrition investigations, this Department is cooperating with the Department of the Interior in an investigation of the diet of the inmates of the Government Hospital for the Insane (St. Elizabeth's). Results of unusual interest have been obtained, which await publication, and it seems only fair to say that a continuation and extension of such inquiries would be correspondingly valuable.

SOME FEATURES OF RECENT PROGRESS IN AGRICULTURAL EDUCATION.

By A. C. True, *Director of Office of Experiment Stations.*

The past year has been a notable one in the history of the movement for definite education in the science and practice of agriculture in the United States. Along almost all lines of agricultural education there has been unusually rapid progress; but especially in the differentiation of different grades of instruction in agricultural branches and in the organization of separate courses and institutions to meet the needs of students of different ages and attainments has there been remarkable activity. In this article an attempt has been made to show some of the main features of this advancement and to illustrate them by concrete examples of institutions successfully organized on a new and progressive basis.

GRADUATE SCHOOL OF AGRICULTURE.

A new enterprise in agricultural education has been inaugurated by the establishment of the Graduate School of Agriculture, which held a four weeks' session during the month of July, 1902, at the Ohio State University, Columbus, Ohio. The plan for this school was originated by Prof. Thomas F. Hunt, dean of the College of Agriculture and Domestic Science of the Ohio State University, the purpose being to establish a school for advanced students of agriculture at which leading teachers and investigators of the agricultural colleges and experiment stations and this Department should present in some regular way summaries of the recent progress of agricultural science, illustrate improved methods of teaching agricultural subjects, and afford a somewhat extended opportunity for the discussion of live topics drawn from the rapidly advancing science of agriculture. This idea received the cordial approval of President Thompson, of the Ohio State University, and on the recommendations of these two men the board of trustees of the university voted to establish such a school and generously made provision for the financial support of its first session.

The Association of American Agricultural Colleges and Experiment Stations at its convention in 1901 favored the plan for the school and voted that if the success of the first session seemed to justify its continuance, it be made a cooperative enterprise under the control of the

association. The Secretary of Agriculture also expressed his cordial approval of this movement, and on his advice the Director of the Office of Experiment Stations consented to act as dean and other officers of the Department of Agriculture to be members of its faculty. Under these favorable auspices there was little difficulty in securing a strong faculty. As actually organized this included 35 men, of whom 26 are professors in agricultural colleges, 7 are leading officers of the Department of Agriculture, and 2 are officers of the New York State Experiment Station. Courses were offered in agronomy, zootechny, dairying, and breeding of plants and animals. The school was housed in the substantial and well-equipped agricultural building of the Ohio State University, where were illustrated the most improved apparatus of instruction in soil physics, dairying, and other agricultural subjects. Besides the live stock of the university farm, leading breeders of Ohio furnished choice animals for the stock-judging exercises.

General problems of agricultural science and pedagogy were discussed at the inaugural exercises and at Saturday morning conferences. Among the topics thus treated were the history of agricultural education and research in the United States; the organization of agricultural education in colleges, secondary schools, nature-study courses, correspondence courses, farmers' institutes, and various forms of university extension; what constitutes a science of agriculture; and methods and value of cooperative experiments. Through social assemblies, visits to typical Ohio farms, and much informal discussion whenever the students met each other, the educational influences of the school were greatly extended. Seventy-five students were in attendance. These were drawn from 28 States and Territories, including such widely separated regions as Maine, Oregon, California, New Mexico, and Alabama. There was one student from Canada and one from Argentina. There was also one woman, and the colored race was represented by teachers from the Tuskegee Institute and the North Carolina Agricultural College. Twenty-seven of the students are professors or assistant professors of agriculture in agricultural colleges, 31 are assistants in the agricultural colleges and experiment stations, 9 are recent college graduates, and 8 are engaged in farming.

Considering the character of the faculty and students, it goes without saying that the whole period of the session was occupied with the most earnest and profitable work. Without doubt the influence of this school will be felt throughout the country in the improvement of courses of instruction in agriculture and the strengthening of the lines and methods of investigation of agricultural subjects. In other ways the school will exert a beneficial influence. So rapid has been the accumulation of materials for a real science of agriculture during the past few years that even professional students of agriculture have not realized how large a mass of knowledge is already available for mold-

ing into a systematic body of truth which may be utilized for pedagogic purposes, as well as for inductions of scientific and practical value. The summaries given by the experts gathered at this graduate school have emphasized this fact and shown in a striking manner that agricultural education and research may now be properly and efficiently organized with reference to the science of agriculture itself rather than be, as heretofore, very largely a matter of the sciences related to agriculture. This will serve to stimulate greatly the movement already begun for the reduction of materials of agricultural science to "pedagogic form" for use in colleges and secondary schools, and for the reorganization of agricultural institutions of research on the basis of the divisions and subdivisions of agriculture, instead of physics, chemistry, botany, and other primary and secondary sciences. The day will thus be hastened when the science of agriculture will rank with such tertiary sciences as geology, geography, and medicine as one of the great systems of knowledge of direct benefit to mankind.

The objects and aims of this school were explained by the dean in an address at the inaugural exercises, from which the following paragraphs are taken:

Our system of agricultural education and research, which vitally affects the progress of our vast agricultural interests, has developed very rapidly, its effective organization covering only about one-quarter of a century. Especially within the last decade there has been a remarkable development in the amount and variety of agricultural research, in the methods of agricultural education, and in the financial resources of the institutions for agricultural education and research. This has led to rapid changes in the organization and work of these institutions, and in the requirements of training and experience which are considered essential to the success of agricultural teachers and investigators. The demand for work on these teachers and investigators has also rapidly increased in variety and amount. Under the existing organization of our agricultural colleges and experiment stations the workers must very often be both teachers and investigators.

Very few of our agricultural colleges are as yet able to do more than give their students an undergraduate course in agricultural subjects, and in a considerable number of those institutions even the courses which lead to a bachelor's degree are not yet raised to the standard set by our older and stronger colleges. We are just passing out of the era when boards of trustees considered that they had done enough for agriculture as a part of the college curriculum by having on the faculty one man whom they denominated a professor of agricul ture. Considerable progress has of late been made in the division of the general subject of agriculture into branches and specialties to be taught by different members of college faculties, and a few of our stronger universities and colleges have advanced sufficiently in this

direction to have established what in some real sense may be called an agricultural faculty. But it is still true that the opportunities for thorough training in agricultural science, such as is given in other sciences and in preparation for the old learned professions, are inadequate. If this school does nothing more than to illustrate in some measure what may be done in the differentiation of agricultural subjects and the development of agricultural faculties for university instruction in agriculture it will have served a useful purpose.

In considering the work of such a school as this it must be remembered that the regular college course in agriculture, however well planned and conducted, can do little more than give the student general instruction in the principles of agriculture. It will not ordinarily make him an expert in any one line. There is a need of higher instruction in the different branches of agricultural sciences in order that we may have thoroughly trained agricultural specialists and experts. We can not hope to attain and maintain leadership in the application of science to agriculture without university instruction in agricultural science. The agricultural schools and colleges may give sufficient training to fit men to succeed well as farmers, farm managers, teachers of the general science of agriculture, and editors of agricultural journals. But the graduates of these institutions attempting to do high-grade teaching or investigating must have some further means of securing the thorough and special training they require. One aim of this graduate school is to provide a certain measure of this advanced and special instruction and thereby to illustrate some of the lines along which our universities need to establish advanced courses of instruction in agricultural specialties. The response which has been made to the call for teachers and students to organize this school is a good indication of the general widespread feeling among the men already engaged in the work of instruction and research in agriculture in this country that there is a real need for deeper and wider instruction in agricultural science.

The need of a larger number of men and women well trained in agricultural science and familiar with the most approved methods of agricultural practice is keenly felt in various directions. Not only is the present supply of competent workers in these lines inadequate to meet the enlarged demand for professors and investigators in our agricultural colleges, experiment stations, and departments of agriculture, but the spread of agricultural instruction into secondary schools of agriculture and into our public high schools is greatly hindered because teachers trained in agricultural subjects are lacking.

The comparatively few men well trained for service in agricultural institutions, farmers' institutes, and, generally speaking, in the cause of agricultural advancement on rational and scientific lines are badly overworked at present. We must have more workers of the right

kind to swell the ranks of the vanguard of agricultural progress, and it is hoped that this school will do something to find and train recruits for this honorable service.

The cause of agricultural education and research is developing under peculiar conditions. Popular interest in this matter is already so great that demands are made upon the workers in our colleges and stations far beyond their ability to meet. At the same time through their own efforts, and those of workers in kindred institutions at home and abroad, the materials for a true science of agriculture are accumulating faster than they are being reduced to a systematic form. While it is true that within the past few years there has been an unusual amount of activity in book writing on subjects pertaining to agricultural science and practice, yet there remain many agricultural subjects on which there are no treatises that can be considered fairly up to date. Moreover, books of reference, including dictionaries and encyclopedias, have not kept up with the advance of knowledge along agricultural lines, though within the past few years the makers of such works have made hopeful progress in this direction. In many lines of agricultural education and research the methods of instruction and investigation have not been thoroughly proved, and the apparatus and illustrative material needed in agricultural laboratories, schools, and colleges are as yet very inadequate.

This school may therefore serve a very useful purpose in bringing to its students summaries of up-to-date information on various agricultural subjects, and in pointing out ways in which the methods of teaching and investigating agricultural subjects may be improved and the apparatus and illustrative material for instruction and research in these subjects may be increased in variety and effectiveness.

Like other great progressive movements of our day, the cause of agricultural education and research needs systematic promotion in two directions. Well-defined plans are needed for the development of our institutions for agricultural education and research to meet the enlarged demands of our people for information and training in these lines. We do well, therefore, to bring the workers in our agricultural institutions together to discuss the organization and development of our system of agricultural education and research. But there is also required a more thorough discussion of the methods of instruction and research in agriculture. It is true that we already have some means for carrying on general discussion in both these directions. The Department of Agriculture, especially through its Office of Experiment Stations, has acted as a center for the collection and dissemination of information regarding the organization of agricultural education and research and methods of teaching and investigation. The Association of American Agricultural Colleges and Experiment Stations has also served a most useful purpose in both these lines of

endeavor. It has, however, been felt by many of the managers and workers in our agricultural institutions that neither the dissemination of publications nor the brief meetings of the Association of Colleges and Stations sufficiently met the need for a center of discussion for these general problems. For this reason the proposition for the establishment of this Graduate School of Agriculture met with much favor among the general officers of our institutions for agricultural education and research as well as among the workers in these institutions. Though the period during which the sessions of this school can be held is necessarily brief, it nevertheless gives a much longer time for the discussion of these problems than is afforded by the meetings of the Association of Colleges and Stations. By bringing together here for a month a considerable number of our leading agricultural teachers and investigators in these lines and a select body of the more recent graduates of our agricultural colleges who are just entering or about to enter on the work of teaching and investigation, it is believed that we have a more efficient opportunity for live discussion of up-to-date problems of agricultural education and research than has hitherto existed.

Through the generous liberality of the trustees and officers of the Ohio State University, the broad-minded approval of the honorable Secretary of Agriculture, and the cordial cooperation of the Association of American Agricultural Colleges and Experiment Stations it has been possible to put this enterprise on an efficient basis, and the school therefore begins its sessions under most favorable auspices. Considering the character of its faculty and students there is every reason to believe that the entire session of the school will be filled with the most earnest teaching and the most thorough discussion of the subjects included in the course. In an unusual measure we believe this school will furnish inspiration and up-to-date knowledge to workers in our agricultural institutions, gathered out of many States and Territories; but beyond this, we believe that in its ultimate results this school will greatly aid in the formation of public opinion in favor of the more thorough and rational organization of agricultural education and research in the United States.

The school will aim to solidify and amplify the organization of education and research in agricultural subjects on the basis of agriculture itself, considered as both a science and an art. It will seek on the one hand to help on the movement for grouping the results of investigation in many scientific lines into a fairly well-defined body of knowledge, to be known as the science of agriculture, comparable with such sciences as geology, geography, and medicine, and on the other hand to quicken and broaden the movement for the direct application of science in manifold ways to the art of agriculture. While we expect to pursue our work with high standards of scientific and pedagogical effort, we will not for a moment lose sight of the farmer and the requirements

of practical agriculture. All our labor will be counted as in vain if it does not issue sooner or later in the growing of plants and animals better adapted to the uses of men and the evolution of a system of farming in which the financial returns shall be more satisfactory to the intelligent and thrifty farmers, and under which the general level of intelligence, comfort, and upright and harmonious living of our rural population shall be perceptibly and increasingly raised.

We believe that the wide movement for the establishment of agricultural schools, colleges, experiment stations, and departments of agriculture, from which already such important results have come, has in it vast potentialities not only for the bettering of the financial and other material conditions of the rural population, but also, and far more, for their intellectual and moral quickening. Wherever there is a definite movement by which men pursue systematic and long-continued investigations along the line of any industry, whether in the realm of administration, invention, or science, with the result that the organization, processes, and appliance of that industry are changed in the direction of more thorough system and greater complexity, there follows necessarily higher intellectual activity and a more elevated morality in the mass of workers in that industry.

Our aim, therefore, is a high one and our inspiration to the most strenuous effort in the few weeks in which we are assembled in this school is a lofty one. We seek to lay the lines and set the pace by which the workers in the cause of agricultural education and research in every State and Territory of this Union and in the most distant island over which our flag floats shall march to the conquest of new facts and principles which may be utilized for the advancement of agricultural practice and the more efficient instruction of the farmer and his children along agricultural lines.

Papers on the science of agriculture and the educational values of courses in agriculture were read at this school by its dean, the substance of which is given below:

THE SCIENCE OF AGRICULTURE.

In order to make an intelligent and correct answer to the question whether there is a science of agriculture, we must first clearly understand what is meant by the terms "science" and "a science." For this purpose we may fairly appeal to books of reference in common use which have been brought reasonably well up to date, so that they may be taken as expressing the consensus of scholars on this subject in our day. I ask your attention, therefore, first to the definition of science given in Johnson's Encyclopedia, revised edition:

Science.—In a general sense, knowledge reduced to order; that is, knowledge so classified and arranged as to be easily remembered, readily referred to, and advantageously applied. All science is based on the assumption that the laws of nature

are immutable. From this point of view science may be regarded as a knowledge of the laws of nature, embracing the process of experiment, observation, and comparison, by which they are discovered, and the modes of reasoning by which their operation in the production of phenomena is made known. Hence most widely it signifies the knowledge of a truth in relation to other truths.

Next let us examine the definitions of "science" and "a science" given in the Standard Dictionary:

SCIENCE.—(1) Knowledge gained and verified by exact observation and correct thinking, especially as methodically formulated and arranged in a rational system; also, the sum of universal knowledge.

Science in the wide sense includes (1) *science proper*, embracing (*a*) exact knowledge of *facts* (historical or empirical science), (*b*) exact knowledge of *laws*, obtained by correlating facts (nomological science), and (*c*) exact knowledge of *proximate causes* (rational science); and (2) *philosophy*. In the narrow sense of positive science the word is used as including only the first two divisions of science proper.

A SCIENCE.—(2) Any department of knowledge in which the results of investigation have been worked out and systematized; an exact and systematic statement of knowledge concerning some subject or group of subjects; especially a system of ascertained facts and principles covering and attempting to give adequate expression to a great natural group or division of knowledge, as the *sciences* of astronomy, botany, chemistry, and medicine; the *science* of theology.

We may, then, have a "Science of Agriculture," provided there is a body of knowledge about agriculture which has been "gained and verified by exact observation and correct thinking," and "in which the results of investigation have been worked out and systematized."

This science should embrace (*a*) an exact knowledge of facts and (*b*) an exact knowledge of laws, obtained by correlating facts.

But there are different kinds of facts and laws, and in order to see what is the real character of the Science of Agriculture and its relation to other sciences it will be well to make at least a rough classification of sciences.

There are, first, the mathematical and physical sciences, which deal with the facts and laws of number and space and the properties of matter The mathematical sciences are algebra, arithmetic, and geometry. The physical sciences, considered as the sciences which treat of dead matter, or of energy apart from vitality, are astronomy, mechanics, physics, and chemistry.

These sciences which deal with the ultimate constitution of matter may for our purpose be termed Primary Sciences.

Some may also consider biology, as the science of life or living organisms, as a primary science; but as a matter of fact, we study under the head of biology very largely the physics and chemistry of the matter comprising living organisms, so that biological sciences are really complex sciences which deal not so much with the ultimate constitution of matter and life as with secondary facts and phenomena as revealed in living organisms. They belong, therefore, to what may be called Secondary Sciences.

Thus physiology is very largely the physics and chemistry of the plant or animal, as mineralogy is the physics and chemistry of minerals. These secondary sciences of course have their descriptive side, under which the objects with which they deal are described and classified. Among the secondary sciences are botany, zoology, physiology, mineralogy, etc.

There is a third class of sciences which are of a still more complex nature, dealing with large complex objects or groups of objects, and making use in special ways of the facts and laws included in the primary and secondary sciences. Such, for example, are the sciences of geology, geography, and medicine, and in this class I would also put the science of agriculture. For our purpose, at least, we may call these sciences Tertiary Sciences.

Without doubt greater refinements of classification would be required if we were making an exhaustive study of the relations of the various sciences to each other. We should at the outset of such a study find great difficulty in exactly defining the boundaries of each science, for the more closely we study the different forms and groups of matter and living organisms the more clearly we see the intermingling and overlapping of laws and phenomena. The relations of this to our present subject I shall briefly consider later. It will, however, help to remove difficulties in defining the science of agriculture if we keep in mind the somewhat rough and ready classification of sciences, which I have made into three groups—Primary, Secondary, and Tertiary.

The primary sciences are those which deal with the constitution of things.

The secondary sciences are those which classify and describe natural objects and explain their constitution and functions—on the basis of the primary sciences.

The tertiary sciences are those which deal with aggregations of natural objects correlated so as to form a natural or artificial system, which may be described as a whole, and the constitution and functions of which may be explained on the basis of the primary and secondary sciences.

From the complex and diverse nature of the systems with which the tertiary sciences deal it is hardly to be expected that they can be satisfactorily classified, or that they will individually permit of rigid and adequate definition. It will always be somewhat difficult to differentiate them absolutely from the sciences underlying them, but in this respect they differ only in degree from the primary and secondary sciences. In the development of modern science, with its almost limitless ramifications and the numerous points of view from which scientific investigations may be pursued and their results recorded, it is no longer possible to make logical and fixed boundaries for particular sciences. Whether the science of nutrition, for instance, shall be con-

sidered physiological chemistry or chemical physiology or a branch of biology—either botanical or zoological—will depend a good deal on the point of view of the scientist defining it.

Nevertheless, I believe it is possible to sufficiently differentiate the individual tertiary sciences so that they may be considered as organic wholes rather than mere aggregations of underlying sciences. And, as I shall endeavor to show later, I deem it very important that they should be thus differentiated and studied. Let us, therefore, examine the definitions which may fairly be given to some of these tertiary sciences.

The following outline of the main divisions of the sciences of geology, geography, medicine, and agriculture may make clearer the comparative view of these sciences presented herewith:

GEOLOGY (science of lithosphere):
- Dynamic Geology.
- Petrography.
- Structural Geology.
- Physiography.
- Historic Geology—
  - Stratigraphic.
  - Paleontologic.
- Economic Geology.
- Geologic Technology.

GEOGRAPHY:
- Mathematical (*a*) Astronomical.
  - (*b*) Mathematical proper
    - Geodesy.
    - Topography.
    - Cartography.
- Physical (*a*) Physiography.
  - (*b*) Hydrography.
- Political (*a*) Ethnography.
  - (*b*) Ethnology.

MEDICINE:
- Pathology.
- Medical Chemistry.
- Pharmacology.
- Therapeutics.
- Surgery.
- Hygiene and Sanitation.
- Medical Jurisprudence.

AGRICULTURE:
- Plant Production
  - Agronomy.
  - Horticulture.
  - Forestry.
  - (Breeding. Culture. Preservation.)
- Zootechny
  - Mammaliculture.
  - Aviculture.
  - Pisciculture.
  - Apiculture.
  - Sericulture.
  - (Breeding. Nutrition. Management.)
- Agrotechny.
- Rural Engineering.
- Rural Economics.

Geology, as the science of the earth, or more strictly of the lithosphere, may be subdivided as stated above. The relation of Geology to other sciences is thus stated by G. K. Gilbert in Johnson's Cyclopedia:

> It is related to physical geography, the science of the surface. This relation is peculiarly intimate, because the same series of changes which have produced the texture and structure of the crust have also produced the forms of the surface, so that the processes of change belong alike to dynamic geology and physical geography; and physiography is claimed by both sciences. Mineralogy, though strictly a department of chemistry, is interwoven with petrography, and their relations are doubtless destined to become still more intimate as the genesis of rocks and minerals comes to be better understood. Paleontology, though an inseparable part of historic geology, is equally inseparable from biology; but while neither affiliation can be

abandoned, there is a well-developed tendency to divide this science into two parts—biologic paleontology being concerned chiefly with the sequence or evolution of living forms as illustrated by fossils, and geologic paleontology with the association of fossils in faunas and floras.

The development of the *Science of Geography* is well shown for our present purposes in the following extract from an article by Guyot and Gilbert in Johnson's Cyclopedia:

Geography is, literally, a description of the earth. This is *General Descriptive Geography.* But the great process of physical and natural science, as well as the science of man in all his conditions, has awakened a desire for a higher, more comprehensive, and intelligent knowledge of the earth. To describe without rising to the causes and descending to the consequences of the phenomena is not science. The reflective mind craves more. While studying the earth in its natural aspects, it wishes to learn why these natural phenomena are as they appear, how they are produced, and what laws govern them. It seeks to understand the relations of mutual dependence that bind them together, as causes and effects, into a vast system, into one great individual mechanism, which is the terrestrial globe itself, with all it contains. Such a science must endeavor to discover those incessant mutual actions of the different portions of physical nature upon each other, of inorganic nature upon organized beings—upon man in particular—and upon the successive development of human societies; in a word, to study the reciprocal action of all these forces, the perpetual play of which constitutes what might be called the life of the globe. This is *Scientific Geography,* which may be defined as the science of the general phenomena of the globe, and its life, in reference to their connection with mutual dependence.

It may be asked whether a science which thus embraces the whole domain of nature and man has a claim to an individual existence; but when geology has taught the composition of the earth's crust and the history of its gradual formation, physics, the laws which govern matter; when botany and zoology have classified the plants and animals according to their affinities and differences in a grand system of life; when ethnography and history have done their special work it still remains for geography to trace out the relations of these various orders of things to each other. Geography needs the results of all these sciences, but is not to be confounded with them.

Geography, as the science of the earth, is naturally divided into three great departments corresponding to three orders of facts: The earth considered as a planet, a part of the solar system, or *Astronomical Geography;* the earth considered in itself, the *Geography of Nature,* or *Physical Geography;* the earth considered as the abode of man, the *Geography of Man.* These three departments are usually called *Mathematical, Physical,* and *Political Geography.*

I have given this account of geography because it illustrates very well on what broad lines a Tertiary science may be constructed. Geography, as a science in this modern sense, is of very recent date and has hardly yet passed the time of struggle for recognition as a distinct science. This is not remarkable, because the new science of geography embraces material drawn from many sciences. Mathematics, physics, botany, zoology, geology, astronomy, meteorology, ethnology, and statistics—these at least are embraced in geography, and there have been many scientists (of whom a few remain unto this present day) who have claimed that geography is merely a loose aggregation of materials drawn from different sciences, and should

therefore not be considered as a distinct science. Others have claimed that it is merely a branch of some existing science, e. g., astronomy or geology. But as geographers have kept at their work and have elaborated and correlated the different parts of the science of geography, the distinctiveness of this body of knowledge has become more apparent and the advantages of studying the subjects included in geography in a systematic way according to their groupings as geography have been more clearly revealed. Hence in our best institutions for higher learning, instead of being contented with giving the student instruction in the sciences related to geography, special and distinct courses in geography are being offered, and it is coming to be recognized that even the teachers of elementary geography should have special training in the science of geography in the normal school, or the college or university.

The *Science of Medicine* is one of the Tertiary sciences, which, like the science of agriculture, has been profoundly affected by recent researches in other sciences. It is, therefore, in process of reconstruction. And one marked effect of the remarkable widening of the scientific basis of the *practice* of medicine has been that the *science* of medicine has lost that clear-cut definition which in past times it was thought to have. For this reason, while there are numerous old treatises in which elaborate classifications of the science of medicine are set forth, such classifications have almost entirely disappeared from the recent literature of medicine. At the same time we have in medical institutions and treatises an advancing elaboration and differentiation of courses and subjects bearing on the science of human disease and its prevention or cure. On the basis of a thorough study of the constitution, morphology, and physiology of the normal human being, the modern science of medicine embraces pathology (anatomical and physiological), medical chemistry, pharmacology, therapeutics, surgery, hygiene and sanitation, and medical jurisprudence. Medicine is then a science which uses materials drawn from many sciences. These materials are grouped in new and special ways with reference to their ultimate usefulness as a basis for an art or practice. This practice is clearly differentiated from the science and yet indissolubly united with it. In this respect medicine and agriculture are comparable. In the case of both there is a science (now, as we believe, on a sound basis and rapidily developing along right lines); but there is also a practice, which is every year being more profoundly and beneficially affected by the science explaining the principles on which its processes are founded and revealing the facts and laws by means of which its operations may be further improved.

The *Science of Agriculture* is that body of knowledge (gained and verified by exact observation and correct thinking, methodically formulated and arranged in a rational system) in which the facts relating

to the production of plants and animals useful to man and the uses of these plants and animals are accurately set forth, and a rational explanation is given of the phenomena and laws involved in such production and uses. It is obvious that this body of knowledge may be variously subdivided, according to different purposes of study or application. But in order to bring out more clearly my conception of the science, I shall now attempt to make and define one series of subdivisions.

Agriculture, as the science of the production and use of plants and animals useful to man, may be divided into Plant Production, Animal Production or Zootechny, Agricultural Technology or Agrotechny, Rural Engineering, and Rural Economics.

Under Plant Production is included whatever relates to the natural or artificial environment (i. e., climate, soil, water, fertilizers) of useful plants, their structure, composition, physiology, botanical relations, varieties, geographical distribution, culture, harvesting, preservation, and uses, and the obstructions to their growth, preservation, or use. Plant Production may be subdivided into Agronomy, which deals with what are commonly called field or farm corps; Horticulture, which deals with vegetables, fruits, and ornamental plants, especially as grown in gardens, small plantations, or parks; and Forestry, which deals with trees and shrubs grown in large tracts. It is obvious that the boundaries of these divisions of Plant Production can not be very exact. Whether sweet potatoes or beans shall be called agronomical or horticultural crops will depend largely on the conditions of their culture; and whether a certain kind of a tree shall be considered a forest tree or an ornamental plant, will depend on the method of its culture and use. The science of Plant Production derives its materials from meteorology, agricultural physics and chemistry, economic botany, bacteriology, vegetable physiology and pathology, economic entomology, economic zoology, and perhaps from other sciences. But these materials may be grouped in their relations to the processes involved in the production and uses of different kinds of plants, so as to form a distinct body of knowledge fairly entitled to the name of Science of Plant Production as one of the divisions of the Science of Agriculture.

The Science of Plant Production may be subdivided either according to groups of plants as suggested above, i. e., into Agronomy, Horticulture, and Forestry, or along other lines, e. g., Plant Breeding, Plant Culture, and Plant Preservation. Thus the plant breeder may be differentiated from the plant physiologist as a man who is an expert in the science of improving the varieties of useful plants for particular purposes, taking into account the climate and soil in which the plants are to be grown, and the economic uses to which they are to be put. He must be a plant physiologist; but if he is only that, he will not be a successful plant breeder. The plant culturist should understand the physics and chemistry of soils, the botanical relations and physiology

of useful plants, the uses to which these plants are devoted, and the weeds, fungi, bacteria, insects, and other pests which may impede their growth. He must know all this in relation to the problems of the growth of plants under the actual conditions in field and greenhouse, or he has not mastered the science. to say nothing of the art of plant culture.

The second great division of the Science of Agriculture is Animal Production, or Zootechny. This includes whatever relates to the anatomy, physiology, zoological relations, domestication, types and breeds, breeding, feeding, hygiene, management, and uses of useful animals. It may also include the science which treats of diseases and other impediments to the production of animals, i. e., Veterinary Science, though this is in itself a large and distinct body of knowledge, and bears only the same relation to Zootechny that the science of medicine bears to anthropology.

Zootechny may be subdivided, according to the kinds of animals studied, into Mammaliculture, Aviculture, Pisciculture, Apiculture, Sericulture, or into such branches as Animal Breeding, Animal Nutrition, and Animal Management.

Agrotechny includes whatever relates to the conversion of raw materials produced in agriculture into manufactured articles for use in commerce and the arts. It may also include the processes of handling these raw materials in connection with their commercial uses, as in the case of milk and cream sold for consumption. It also involves whatever relates to departures from standards set for manufactured articles, i. e., adulterations and sophistications, in somewhat the same way that the diseases of plants and animals are related to Agronomy and Zootechny. Agrotechny is naturally divided into specialties according to the kinds of materials, e. g., foods and feeding stuffs, liquors, oils, textiles, and leather. The subdivision of most importance as a subject of school instruction in the United States is dairying.

Rural Engineering includes those branches of civil and mechanical engineering which relate to the locating, arranging, and equipment of farms and the construction and operation of farm implements and machinery. It embraces the surveying of farms, the location of farm buildings and works, the construction of buildings, water, irrigation, drainage, and sewage system, and roads. It also involves the principles of mechanics as applied to farm machinery and the use of different kinds of power for agricultural purposes. As a branch of the Science of Agriculture it involves an understanding of the requirements of the plants and animals to be grown and used on the farm, as well as the needs of the human inhabitants as related to engineering problems.

Rural Economics may be more or less broadly defined according to the point of view. It at least includes whatever is related to agricul-

ture considered as a means for the production, preservation, and distribution of wealth by the use of land for the growing of plants and animals. It may include the development of agriculture as a business (history of agriculture), as well as the facts and principles of farm management under present conditions. If formulated and studied in its relation to the production and uses of useful plants and animals, Rural Economics may fairly be claimed to be a branch of the Science of Agriculture, though the same facts and principles may easily be so grouped as to make a subdivision of political economy or sociology.

It should be understood that, while insisting on the existence of a real Science of Agriculture, I do not claim that the boundaries of this science can be determined with anything like mathematical precision. But this is, as has already been said, also true in greater or less degree of all the sciences.

It is also true that in making subdivisions of any science scholars do not now insist on rigid divisions, or attach any very great importance to any particular scheme of classification. But when this has been granted it must be insisted that, for such purposes as the organization of courses of study and the administration of great institutions of research, there should be the recognition of such sciences as geology, geography, medicine, and agriculture as the basis for the organization of the curriculum or administrative system; for practically a good deal depends in our colleges and scientific institutions on the point of view of the managers, teachers, and investigators. As long as we admit the nonexistence of a Science of Agriculture, and are satisfied with aiding agriculture through teaching and investigation in the sciences related to agriculture, we shall have boards of trustees and college presidents who will be satisfied when their chemists, physicists, and botanists add to their ordinary teaching of the principles of chemistry, physics, and botany a limited amount of information regarding the application of those sciences to agriculture; and the teachers themselves, approaching the subject from the standpoint of the primary or secondary sciences, will be most likely to subordinate the agricultural side of their instruction to the general view of their favorite science; so that the pupils will learn a great deal more about the relations of agricultural subjects to botany or chemistry than they will about the relation of botanical and chemical knowledge to the production of useful plants and animals.

The establishment of such an organization as the Bureau of Plant Industry in the Department of Agriculture marks an immense gain, not only in effectiveness of administration, but in the relation of the scientific effort of the investigators to agriculture. Now, the men in that Bureau feel that they are working primarily as agricultural scientists rather than merely as botanists. Their outlook toward their work is changed; there is a disposition to lay under contribution every

science required to work out the complex problems of agriculture, and there is every reason to believe that they will accomplish for the Science of Plant Production, as part of the Science of Agriculture, what that great Bureau known as the Geological Survey has done for the Science of Geology. All questions regarding the exact boundaries of the Science of Agriculture or of its subdivisions sink into insignificance when compared with the substantial fact that there is a rapidly increasing body of knowledge which fairly constitutes a Science of Agriculture, and that by organizing our colleges of agriculture, experiment stations, and Department of Agriculture on the basis of this science we may secure such increased efficiency of work and administration as will greatly widen the scope and thoroughness of this science, and, through its effective application to practice in an ever-increasing number of ways, do more to improve the art of agriculture than would ever be possible as long as there were simply fragments of knowledge regarding agricultural subjects scattered through a score of sciences.

The fact that there is an art of agriculture, and that this art in its cruder forms involves comparatively simple operations, in no way militates against the need and feasibility of having a science of agriculture. There is a practice of medicine as well as a science of medicine. In his humbler work the doctor or the surgeon performs many simple manual operations which have been similarly performed for thousands of years and long prior to the formulation of any science of medicine.

We readily grant that the operations of agriculture may be performed by persons ignorant of the science, but it is already evident that a right knowledge of the science may be very helpful in the practice of the art. It is also becoming apparent that the teaching of chemistry, botany, and zoology, even on their economic sides, is not enough to satisfy the needs of agriculture. There must be teaching of the science of agriculture as such, from the university down.

The method of my present discussion of the science of agriculture has been chosen because there are still those who rank high in scientific and pedagogical circles who claim that there is no such thing as a science of agriculture, and this view of the matter has not only had great influence in shaping courses of instruction and methods of investigation along agricultural lines in the past, but is still operating in our colleges and experiment stations to prevent the formulation of vastly better courses of instruction and methods of investigation in these lines.

Without doubt, the theoretical and practical denial of the possibility of a science of agriculture has had much to do with the comparatively slow growth of the science and the present unsatisfactory condition of agricultural instruction in many of our colleges. Nevertheless, a

science of agriculture has been developed and has already reached such a stage that its claims are each year being more distinctly recognized in our agricultural colleges.

The differentiation of the body of knowledge, which may fairly be called the science of agriculture, from the other sciences will lead to profound changes in the methods of teaching agricultural subjects, the equipment for such instruction, and the arrangement of courses to meet the needs of different classes of students. We are, in fact, already in the midst of such changes. The most obvious result of this movement thus far is the division of the subject of agriculture among several instructors in a college, so as to make at least the beginnings of a real agricultural faculty. Thus we now have quite commonly in our agricultural colleges professors of agronomy, animal husbandry (zootechny), dairying, horticulture, and veterinary science. When a group of instructors is thus formed the natural consequence is a special building in which they may work, to a certain extent at least, in cooperation. When the building is provided it is seen to be appropriate and desirable that it should contain special arrangements, facilities, apparatus, etc., suited to the requirements of the subjects to be taught in it. This leads the instructors in several branches of agriculture to set their wits to work to devise special arrangements and apparatus which will improve the quality and thoroughness of their instruction. Along with this there is more study of the relation of the different topics to each other in a scheme of instruction, the rearrangement of courses, the improvement of methods of teaching, and the discussion of the whole subject of the pedagogy of agricultural science. Such a ferment and development is already making trouble for the presidents and boards of trustees of our agricultural colleges. The simple and inexpensive facilities which have hitherto sufficed for agricultural instruction will no longer do. Agriculture claims, and is now in a position to rightly claim, the same kind of treatment as is now quite generally accorded to engineering and mechanic arts. If the teachers of agriculture are really alive to their business and successful in their endeavors to systematize their subjects and improve the quality of their teaching, they will devise and develop methods, apparatus, and illustrative material which will call for an increased amount of money to properly house and maintain. We shall have failed in one of the great purposes of this summer school if the teachers of agriculture here assembled do not return to their respective institutions better prepared and more in earnest to contend in every proper way for the development and increase of the agricultural faculties. and the facilities for agricultural instruction. This is not a matter of fine buildings and extensive fields. The real problem before the agricultural faculties is to devise more and better apparatus; to discover far better methods of utilizing the college

farm as a real agricultural laboratory; to provide live-stock rooms and barns and plant houses, which will be of more real use as aids to instruction. The more the teachers of agriculture show they have grasped the pedagogic principles involved in the proper presentation of their subjects to students, and the more they collect and utilize appropriate apparatus and illustrative material, the easier it will be to get for them proper housing and equipment. What we need especially now are original and ingenious teachers. Really competent men have a better chance of great success than ever before.

Meanwhile the investigations in progress in experiment stations and the Department of Agriculture and kindred institutions are rapidly widening the boundaries of the science of agriculture and increasing the material for instruction. Those men who are sifting the results of these investigations and writing books and other summaries are performing a very useful service. The science must have a form and body in literature before it can hope for general recognition. Its claims are being recognized in a hopeful way by the editors of dictionaries, cyclopedias, and other general works of reference. The great Cyclopedia of Horticulture marks a distinct gain for the cause of agricultural science, and will, it is to be hoped, soon be supplemented by a Cyclopedia of Agriculture.

There need be no fear that the elaboration of the Science of Agriculture, the definition of its relation to the primary and secondary sciences, and the making of more thorough and severe requirements for courses in agriculture in our colleges will stand in the way of broadening the field of agricultural instruction, so as to make it reach the great body of our youths in agricultural communities, who, from the necessities of their condition and environment, will not be able to attend our colleges. On the contrary, the more definite the Science of Agriculture is made, and the more thorough the pedagogics of agricultural instruction become, the easier it will be to provide good text-books and manuals for elementary instruction in agriculture, and to prepare courses and teachers of agricultural subjects for the lower schools. Hand in hand with the improvement and definition of the Science of Geography, the establishment of university courses on this subject, and the enlargement of geographical research, has gone the improvement of the text-books and manuals of geography in all grades of schools, and the betterment of teachers and facilities for instruction in this subject. The lowest grades of schools, as well as the highest, have realized beneficial effects from the thorough overhauling of geographical science which the past quarter of a century has witnessed. And so it will be with agriculture. As definite results of investigations accumulate, as college courses are improved, as thorough treatises on agricultural science multiply, it will be easier to devise effective and useful nature-study lessons in agricultural subjects for our elementary schools, suitable outline courses in the theory and practice of

agriculture for our high schools, and good secondary courses in general agriculture, in horticulture, in dairying, and in other special branches for the special agricultural schools, which have already been so successfully conducted in a few places, and which we hope and expect to see established before long in many agricultural regions of our country.

I have spoken of these things because I deem it of great importance at this juncture that our teachers and investigators should regard the definition and formulation of a Science of Agriculture as a matter of prime importance. For with the establishment and general recognition of such a science will come, not only the broadening and strengthening of institutions for higher research and education in agricultural subjects, but also a vast widening of the range of agricultural education, until it permeates the mass of our rural population and shows its beneficial results in the general elevation of the intellectual activities of our agricultural people, as well as in the improvement of the material conditions and gains of our agricultural practice. For the Science of Agriculture is one of those peculiar products of our broader and better conceptions of the field and office of science. It exists not for itself alone, but rather for the betterment of mankind.

EDUCATIONAL VALUES OF COURSES IN AGRICULTURE.

The educational values of courses in agriculture are determined by the same pedagogic standards as are applied to courses in other subjects.

According to President Eliot, of Harvard University, the essential constituents of education in the highest sense are as follows: "We must learn to see straight and clear; to compare and infer; to make an accurate record; to remember; to express our thoughts with precision, and to hold fast on lofty ideals." "There is also," he says, "general recognition of the principle that effective power in action is the true end of education rather than the storing up of information or the cultivation of faculties which are mainly receptive, discriminating, or critical."

According to Professor Hanus, professor of education in the same university, the subjects of instruction in a modern school course of study may be classified as follows: "(1) Language and literature; (2) social study—history (including the history of industry and commerce, as well as political history), government, descriptive economics; (3) art (including the history of art, as well as drawing, painting, modeling, music); (4) mathematics; (5) physical and biological science; and (6) manual training."

The first two classes of subjects have a higher educational value, theoretically, provided the student is interested in them, but if he has a greater interest in subjects of the other classes, they may have for him a higher educational value and may be advantageously used for

the development of habits of efficiency. The individuality of the pupil is considered of more importance as the pupil advances in age and maturity. School courses, especially in high school and college, should therefore particularly promote the development of each pupil's dominant interests and powers, and further should seek to render these interests and powers subservient to life's serious purposes, which include self-support or some worthy form of service, and intelligent, active participation in human affairs.

In this view of the educational problem as related to modern civilization with its elaborate industrial system, we do well to unite culture and vocational studies in school and college courses.

In considering the courses of study for our agricultural colleges in the light of these pedagogic principles, we should always bear in mind that a properly constituted agricultural course, taken as a whole, will include both culture and vocational studies. This is well illustrated by the course of study proposed for our agricultural colleges by standing committees of the Association of American Agricultural Colleges and Experiment Stations. This four-year college course includes English, modern languages, psychology, ethics, political economy, general history, constitutional law, drawing, algebra, geometry, and trigonometry, as culture studies; next there are the pure sciences—physics, chemistry, botany, zoology, physiology, geology, and meteorology; lastly, the vocational studies—agriculture, horticulture and forestry, veterinary science, and agricultural chemistry. As regards the time assigned to these subjects, we find two-thirds of the entire course is occupied with culture and scientific studies, leaving one-third of the time for agricultural science and its applications to the art of agriculture.

There is no need, then, to discuss the educational values of two-thirds of this course, for these are already well established. It will perhaps help us to determine more accurately the educational values of the remaining third, i. e., the agricultural portion of the course, if we divide it into two sections. A large part of it consists of the study of the different branches of the science of agriculture. Essentially these have educational values as scientific studies, varying according to their nature and scope. In their entirety they cover quite a wide range, since they include materials drawn from physics, chemistry, various biological sciences, engineering, and economics. Leaving out for the present the manual operations which we desire to consider separately as the second section of the agricultural division of the college course, agricultural science embraces all the other lines of instruction laid down by Professor Hanus, except language and literature; that is, it includes physical and biological science, mathematics, art, and social study. Properly taught, the student of agricultural science will "See straight and clear, compare and infer, make an accurate record,

remember, express his thoughts with precision, and hold fast on lofty ideals."

From the complex nature of the agricultural sciences they should have high educational values along these different lines.

The objects, facts, and phenomena brought before the student of agricultural science are of such a kind as to test his capacity to "see straight and clear" in a very high degree. Whatever previous training he has had in this line will doubtless aid him in this new and higher field of science; but however good his previous training, he will find very much to train and to develop his perceptive powers in observing the complex things involved in agricultural science. The soil, cultivated plants, domestic animals are not simple and elementary things, easy to be apprehended and comprehended. If we are to know them in any accurate sense, we must see straight and clear and long. These agricultural subjects also furnish innumerable opportunities for comparisons, most of which will be far from simple, and the problems of correct inferences in this line of study are as difficult as they are multitudinous.

The classification of soils and the determination of their relative fertility and adaptation to different crops, the judging of live stock on the broad basis of their fitness for particular uses, what opportunities in such studies "to compare and infer." Considered as "mental gymnastics" a class in stock judging may have as much exercise as a class puzzling over the mysteries of the Latin or Greek subjunctive mood—that is, if our agricultural students are taught and not lectured.

No one would dispute that the agricultural subjects give ample opportunity for exercise in "making an accurate record" of what is learned.

Memory certainly need not lack for exercise amid the innumerable multitude of items included in these agricultural subjects. It is undoubtedly a pity that memory training is too much neglected in our modern educational schemes, but this is not for lack of materials on which to work; it is often a lack of proper selection of things to be remembered, or the misguided effort to remember too many unimportant items.

And if ever there were subjects in which it was desirable to express our thought with precision it is these agricultural subjects. If only agricultural writers, teachers, and students would learn to do that, so that we might distinguish between their actual knowledge and their theories, it would be a great gain for the cause of truth and science. And the expression of the thought may come through language or mathematics or the graphic arts.

It also may be fairly claimed that the study of agriculture in its human relations may have an ethical side of much educational value. We should teach men in our agricultural colleges to be intelligent

farmers, not simply that they may thus make a better living, but also that they may be leaders in making agriculture a live, progessive art, which in the future shall provide a more stable and satisfactory basis for thrifty, intelligent, and refined rural communities, as well as a stronger guaranty for the manufactures, commerce, art, literature, and science of a higher civilization, in which industrial and civil peace, and not war, shall be the established order.

But the relative educational value of agricultural courses will depend largely on the methods of teaching employed. Among the pedagogic principles which should underlie good teaching of agricultural subjects are the following:

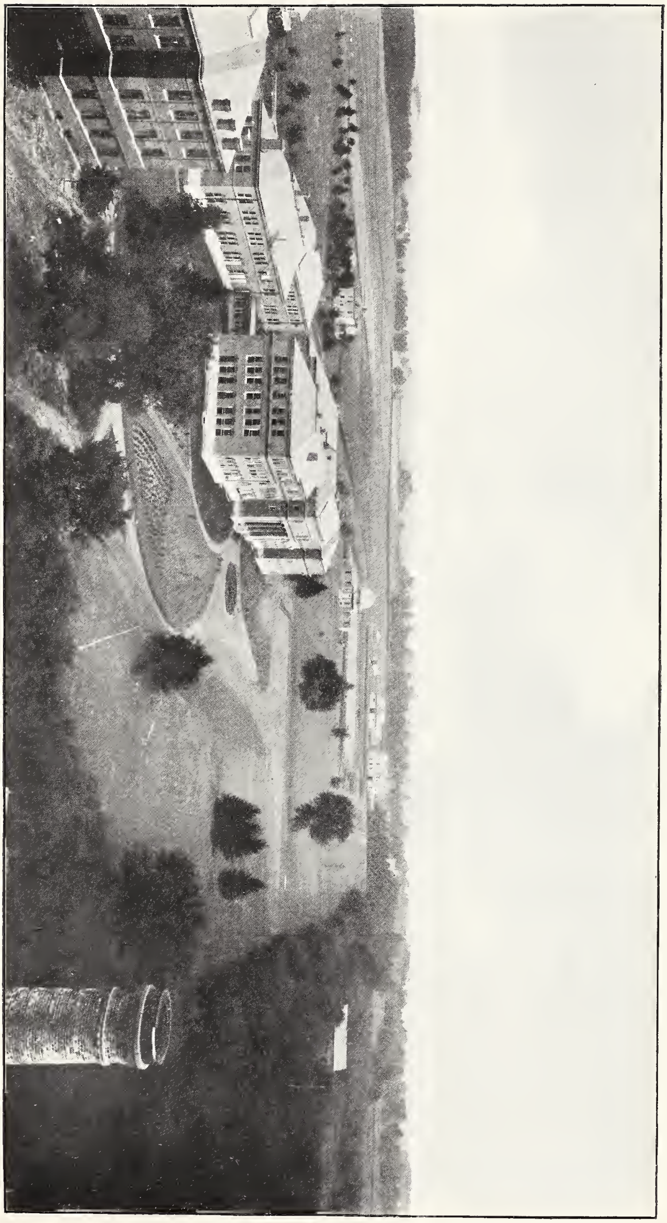
(1) The foundation of educational success in agricultural courses must be laid in the interest of the student. The teacher should, however, remember that this is not the only principle to be observed. There may be much interest without much instruction. The stump speaker often excites his hearers to the highest pitch of interest without giving them any useful information, and a teacher may keep pupils in an excited state of mind without their making any material progress in learning.

(2) There should be careful selection and systematic arrangement of topics to be taught in a given course, so that the student will learn the most important things which he needs to know, and will be put in possession of a system of truth regarding agriculture which he can grasp and hold as a permanent mental possession.

(3) The methods of teaching agricultural subjects should be such as to afford the opportunity and impose the necessity on the student of exerting himself strenuously to gain the mastery of these subjects—hence the advantage of the so-called laboratory methods as contrasted with lecturing.

(4) To give a high educational value to agricultural courses attention must be paid to the time element in education, meaning by this not so much the duration of agricultural courses as the relative amount of mental activity compressed into a given time through skillful teaching. Hence the necessity of much attention to the devising of laboratory methods of instruction which will permit rapid and varied work, the previous preparation of materials, so that there may not be delays in the class room, and the holding of the student to strenuous effort from first to last.

(5) The educational value, of course, in agriculture will also depend on the extent to which they are made the means for developing originality and executive capacity in the students. It is not enough that through such courses the student shall gain much exact and useful knowledge or correct methods of activity. He should acquire ability to seek and find new truth and to guide and control the activities of other men in practical scientific lines. The college graduate is not the



AGRICULTURAL EDUCATION—COLLEGE OF AGRICULTURE, UNIVERSITY OF ILLINOIS.

man he ought to be unless he is capable of adding to the sum of human knowledge and becoming a leader in human progress. The quality of the future work of our experiment stations and departments of agriculture will depend on the original power developed in the graduates from our agricultural courses. The progress of the practical agriculture of this country in competition with the world will depend very largely on the quality of the leadership of the graduates from these agricultural courses. And the organization of the agricultural industries on right lines, as well as the betterment of the social condition of agricultural communities, will naturally depend very much on the work of the agricultural colleges and their graduates. The signs all point to the wider and stronger influence of educated men in the large affairs of industry and public business, including the narrower range of public business which we ordinarily call the government. In these broad lines there will be abundant opportunities for agricultural graduates to make for themselves honorable and useful careers. Their success in this direction will depend largely on the quality of the teaching they receive in agricultural courses.

COLLEGE COURSES IN AGRICULTURE.

The movement for the specialization of the different branches of the science of agriculture and the development of a highly organized faculty in our agricultural colleges has gone furthest in the College of Agriculture of the University of Illinois (Pl. XLII), of which Prof. Eugene Davenport is dean. The aims and scope of the instruction given in this college are set forth in the university catalogue for 1901–2, from which the following statements are taken:

AIMS AND SCOPE.

The College of Agriculture offers students an education designed to fit them for the business of farming and at the same time to furnish a means of culture. This education is, therefore, partly technical and partly cultural. Its end is the training of students to be not only successful farmers, but good citizens and successful men as well. In other words, it seeks to provide an education suitable to the needs of rural people.

Of the courses leading to graduation in the College of Agriculture, the technical portion constitutes about one-half of the entire work of the student. Of the remaining portion of the course, thirty-five hours are prescribed in the sciences nearest related to agriculture. Since the technical subjects are also of a scientific character, the course as a whole is essentially scientific, rather than literary; yet the college is mindful of the educational importance of history, literature, language, and the political sciences, and reasonable attention is therefore given to these subjects and their pursuit is encouraged by a liberal amount of open electives.

The college also offers, through the department of household science, a variety of courses especially treating of the affairs of the home.

METHODS OF INSTRUCTION.

Of the 20 instructors in technical subjects, 16 devote their entire time to agriculture. Instruction is by laboratory work, supplemented by text-books, lectures, and reference readings, which are almost constantly assigned from standard volumes and periodicals. The student is brought into close practical contact with his subject. He takes levels, lays tile, tests the draft of tools, traces root systems of corn and other crops, tests germination of seeds, determines the fertility in soils and the effects of different crops and of different rotations upon soil fertility. He does budding, grafting, trimming, and spraying, and works out problems in landscape gardening. He tests milk, operates separators, makes and judges butter and cheese. He studies cuts of meat and samples of wool, judges a great variety of animals, and has practice in diagnosing and treating their diseases.

EQUIPMENT.

The college keeps on deposit from the largest manufacturers several thousand dollars' worth of plows, cultivators, planters, cutters, shellers, grinders, mowers, binders, engines, etc. It has extensive collections of agricultural plants and seeds and their products. Laboratories are well equipped with apparatus and appliances for the study of manures, fertilizers, fertility of soils, soil physics, soil bacteriology, germination of seeds, corn judging, etc. The grounds of the university and the fields and orchards of the experiment station are always available for illustration in class work. An illustrative series of colored casts of fruit and enlarged models of fruits and flowers, collections of seeds and woods, cabinets of beneficial and noxious insects with specimens of their work, photographs, maps, charts, drawings, and lantern slides all afford valuable material for study and illustration.

Specimens of Morgan horses; Shorthorn, Jersey, Ayrshire, and Holstein-Friesian cattle; Shropshire, Merino, and Dorset sheep, and Berkshire swine afford material for judging. This material, moreover, is largely increased by loans from prominent herds. In the dairy department is a complete outfit for a milk-testing laboratory and for cream separation and butter and cheese making. The department of veterinary science owns a collection illustrating materia medica, a collection of pathological specimens illustrating special abnormal bony development, and a papier-maché model of a horse, capable of dissection, and showing every important detail of structure. In addition are levels, lanterns, microscopes, and cameras, an extensive list of agricultural journals, a complete file of experiment station bulletins from all the States, and an excellent assortment of standard reference books, including nearly all the pedigree registers published.

I ESCRIPTION OF DEPARTMENTS.

AGRONOMY.

The department of agronomy, with a staff of six, gives instruction in those subjects which relate especially to the field and its affairs, as drainage, farm machinery, field crops, the physics and bacteriology of the soil, manures, rotation and fertility, the history of agriculture, farm management, and comparative agriculture. The object is to acquaint the student with the facts and principles connected with the improvement of soils, the preservation of fertility, the nature of the various crops and the conditions governing their successful and economic production, and with the development of agriculture. This object is attained by the application of the laboratory methods of study to these subjects, supplemented with lectures, class-room work, and a free use of standard literature.

ANIMAL HUSBANDRY.

In this department three instructors give courses covering the separate study of sheep, swine, beef, and dairy cattle and their products; heavy and light horses, with their care and training; the management of farm herds, and the principles and practices of feeding and of breeding. The purpose is to familiarize the student with animals, first, as to their fitness for specific purposes; second, as to their care and management; third, as to their improvement by breeding, and fourth, as to the commercial production of animal products. This familiarity is gained by an exhaustive study of the uses of domestic animals, the history and character of their breeds, together with extensive practice in stock judging, supplemented by a careful study of the methods of successful stockmen and of the known principles of feeding and of organic evolution.

DAIRY HUSBANDRY.

Three instructors give extended courses in the study of milk and its economic production; the characteristics of the dairy cow and the management of dairy farms; the separation of cream and the making of butter and cheese; factory management; dairy bacteriology; city milk supply and the standardizing and pasteurizing of milk and cream.

HORTICULTURE.

Five instructors conduct courses in orchard management, small-fruit culture, and vegetable gardening, nut culture, floriculture, landscape gardening, and forestry; in fruit propagation, greenhouse management, and the evolution of cultivated plants, and in commercial horticulture and nursery management. The purpose is to acquaint the student with the principles and practice of fruit raising and vegetable gardening, both for home and market, and with successful methods of combating insect and fungus enemies. The sense of the beautiful is cultivated and given expression in floriculture and landscape gardening, to the end that more of nature's beauty shall pervade the home and its surroundings. The student studies plant life and learns how to propagate, cultivate, and improve the forms that have been found useful or ornamental in the way of vegetables, fruits, flowers, and trees. As in other departments, he follows the methods of the laboratory in that he learns to do by doing, supplementing everything with numerous references to standard literature.

HOUSEHOLD SCIENCE.

The department of household science stands for a recognition of the importance of adequate and proper training for home duties. It aims to provide opportunity for a scientific study of some of the problems of the management of the house, including the distribution of income according to recognized business principles.

The courses of instruction given in the department are planned to meet the needs of two classes of students, viz, (*a*) those students who specialize in other lines of work, but desire a knowledge of the general principles and facts of household science; (*b*) those students who wish to make a specialty of household science by a comprehensive study of the affairs of the home, together with the arts and sciences whose applications are directly connected with the management and care of the home.

The department occupies the entire second floor of the north wing of the agricultural building and is supplied with laboratories, apparatus, and illustrative material, such as charts, specimens of various kinds of building material, and exhibits illustrating the chemical composition and products obtained in the manufacture of certain foods.

The students have access also to the museum of the architectural department, as well as the benefit of close association with the art department.

VETERINARY SCIENCE.

Courses are offered in veterinary anatomy and physiology, in veterinary materia medica, and in the theory and practice of veterinary medicine and surgery. The object is to acquaint the student with the structure and activities of animals in health, the characteristic symptoms of disease, and the materials and methods of successful treatment. He therefore makes careful study of the structure of domestic animals and of the nature of their derangements and the characteristic action of remedial agents. The weekly clinic gives opportunity for practical experience in the diagnosis and treatment of the more ordinary diseases.

COURSES OFFERED.

The College of Agriculture offers the following courses leading to the degree of bachelor of science: Agricultural course; general course.

AGRICULTURAL COURSE.

This course is designed to fit young men for the business and relations of country life. Students may graduate upon completing the studies of the prescribed list (and a specified number of electives).

Classification of subjects.

Prescribed.	Elective.
Agronomy.	Agronomy.[a]
Animal husbandry.	Animal husbandry.[a]
Botany.	Botany.[a]
Chemistry.	Dairy husbandry.[a]
Dairy husbandry	Horticulture.[a]
Economics.	English.
Geology.	Rhetoric.[a]
Horticulture.	Zoology.[a]
Military.	Veterinary science.
Physical training.	
Rhetoric.	
Thremmatology.	
Zoology.	

[A list of the different courses offered in the agricultural subjects, with an outline of the topics included in each course, follows.]

AGRONOMY.

1. *Drainage and irrigation.*—Location of drains and irrigation conduits, leveling, digging, laying tile and pipes, filling, and subsequent care; cost of construction and efficiency; sewers for the disposal of waste water from farm buildings and the sewage from kitchen and toilet; farm water pipes, pipe and thread cutting. Class work, laboratory, and field practice.

2. *Field machinery.*—The tools and machinery of the field—plows, harrows, and hoes; seeders, drills, corn and potato planters; cultivators, weeders, and spraying machines; mowers, rakes, self-binders, corn harvesters and huskers, potato diggers, wagons, etc. Class work and laboratory practice, including setting up and testing machines, noting construction and elements necessary for successful work.

[a] Courses in addition to those prescribed.

3. *Farm power machinery.*—Horsepowers, gas engines, traction engines, windmills, pumps, corn shellers, feed cutters, grinders, and thrashing machines—their construction, efficiency, durability, and care. Class room and laboratory work.

4. *Farm buildings, fences, and roads.*—The arrangement, design, construction, and cost of farm buildings, especially of barns, granaries, and silos; the different kinds of fences, their cost, construction, efficiency, and durability; cost and construction of roads and walks. Class work and practice in designing and drafting buildings, operating fence-building machines, setting and testing fence posts, making walks, etc.

5. *Farm crops.*—Quality and improvement. Judging of corn and oats, wheat grading, methods of improving quality, shrinkage of grain, care of stored crops to prevent injury and loss. Class and laboratory work.

6. *Farm crops.*—Germination and growth. Vitality and germination of seeds, preservation of seeds, methods of seeding; conditions of plant growth; peculiarities of the different agricultural plants in respect to structure, habits, and requirements for successful growth; enemies to plant growth—weeds and weed seeds, their identification and methods of destruction, fungus diseases, such as smut of oats and wheat, and blight, scab, and rot of potatoes, methods of prevention; insects injurious to farm crops, and how to combat them. Class room, laboratory, and field work.

7. *Special crops.*—A special study of farm crops taken up under an agricultural outline—grain crops, root crops, forage crops, sugar and fiber crops—their history and distribution over the earth, methods of culture, cost of production, consumption of products, and residues or by-products. Class work supplemented by practical field work and a study of the results of previous experiments, such as detasseling corn, injury to roots of corn by cultivation; selection and breeding of corn and other crops, with special reference to practices which apply directly to Illinois conditions. Students will have an excellent opportunity to study the work of the agricultural experiment station.

8. *Field experiments.*—Special work by the students, conducted in the field. This work consists in testing varieties of corn, oats, wheat, potatoes, and other farm crops; methods of planting corn, seeding grains, grasses, and other forage crops; culture of corn, potatoes, and sugar beets; practice in treating oats and wheat for smut, and potatoes for scab, and studying the effects upon the crops; combating chinch bugs and other injurious insects. Other practical experiments may be arranged with the instructor. Special opportunities will be given to advanced students of high-class standing to take up experiments, under assignment and direction of the instructor in farm crops, on certain large farms in the State, arrangements having been made with the farm owners or managers for such experiments.

9. *Soil physics and management.*—This course is designed to prepare the student better to understand the effects of the different methods of treatment of soils, and the influence of these methods upon moisture, texture, aeration, fertility, and production. It comprises a study of the origin of soils, of the various methods of soil formation, of their mechanical composition and classification; of soil moisture and means for conserving it; of soil texture as affecting capillarity, osmosis, diffusion, and as affected by plowing, harrowing, cultivating, rolling, and cropping; of the wasting of soils by washing; fall or spring plowing and drainage as affecting moisture, temperatures, and root development. The work of the class room is supplemented by laboratory work, comprising the determination of such questions as specific gravity, relative gravity, water-holding capacity, and capillary power of various soils; also the study of the physical effects of different systems of rotation and of continuous cropping with various crops, and the mechanical analysis of soils.

10. *Special problems in soil physics.*—This work is intended for students wishing to specialize further in the study of the physical properties of soils, and will include the determination by electrical methods of the temperature, moisture, and soluble

salt content of various soils under actual field conditions; effect of different depths of plowing, cultivation, and rolling on soil conditions; effects of different methods of preparing seed beds; the physical questions involved in the formation and redemption of the so-called "alkali," "barren," or "dead dog" soils, and of other peculiar soils of Illinois.

11. *Soil bacteriology.*—A study of the morphology and activities of the bacteria which are connected with the elaboration of plant food in the soil or which induce changes of vital importance to agriculture, with regard to the effects of cropping and tillage upon these organisms, and with special reference to the study of those forms which are concerned with the formation of nitrates and nitrites in the soil, and with the accumulation of nitrogen by leguminous crops. Class room and laboratory work.

12. *Fertilizers, rotations, and fertility.*—The influence of fertility, natural or supplied, upon the yield of various crops; the effect of different crops upon the soil and upon succeeding crops; different rotations and the ultimate effect of different systems of farming upon the fertility and productive capacity of soils. The above will be supplemented by a laboratory study of manures and fertilizers; their composition, and their agricultural and commercial value; of soils cropped continuously with different crops and with a series of crops; of the fertility of soils of different types or classes from different sections of Illinois.

13. *Investigation of the fertility of special soils.*—This course is primarily designed to enable the student to study the fertility of those special soils in which he may be particularly interested, and to become familiar with the correct principles and methods of such investigations. It will include the determination of the nature and quantity of the elements of fertility in the soils investigated, the effect upon various crops of different fertilizers added to the soils, as determined by pot cultures, and, where possible, by plat experiments. This work will be supplemented by a systematic study of the work of experiment stations and experimenters along these lines of investigations.

14. *History of agriculture.*—The history and development of agricultural practice and progress, with special reference to the methods employed in ancient times and the effect upon agriculture of the introduction of rational crop rotations, the intelligent use of fertilizers, the introduction of machinery, and the systematic breeding of animals and plants.

15. *Comparative agriculture.*—Reasons for the differences in the agriculture of different times, peoples, and countries, and why it is that the agriculture of a region or of a farm is a definite and individual problem, together with the need of harmonizing agricultural practice with natural conditions as well as with the findings of science; circumstances that influence agricultural practice, as soil, climate, machinery, race, custom, land tenure, etc., and what is best under different conditions.

16. *German agricultural readings.*—A study of the latest agricultural experiments and investigations published in the German language, special attention being given to soils and crops. The current numbers of German journals of agricultural science will be required and used as a text. This course is designed to give the student a broader knowledge of the recent advances in scientific agriculture, and, incidentally, it will aid him in making a practical application of a foreign language. It is recommended that it be taken after agronomy.

17. *Special work in farm mechanics.*—Students may arrange for special work in any of the lines covering drainage or farm machinery, either in the second semester or the summer.

18. *Investigation and thesis.*—This course varies in the subject-matter of study according to the department in which theses are written. The work is under the direction of the head of the department in which the work is done.

HORTICULTURE.

1. *Principles of fruit growing.*—This course, which is designed for all students in the college of agriculture, deals with the fundamental principles of fruit culture. It embraces a study of location with reference to climate and markets, planting, soil treatment, pruning, protection from insects and diseases, harvesting, and marketing. Recitations, reference readings, and practical exercises.

2. *Small-fruit culture.*—A study of the strawberry, raspberry, blackberry, dewberry, currant, gooseberry, cranberry, and juneberry; each studied with reference to history, importance, and extent of cultivation, soil, location, fertilizers, propagation, planting, tillage, pruning, insect enemies, diseases, varieties, harvesting, marketing, profits. Recitations and reference readings, with occasional practical exercises.

3. *Vegetable gardening.*—Kitchen and market gardening, including a study of all the common vegetables.

4. *Plant houses.*—The construction and management of plant houses, with especial reference to the growing of vegetables under glass. Text-book and laboratory work.

5. *Plant propagation.*—Grafting, budding, layering, making cuttings, pollination, seedage, etc. Text-book and laboratory work.

6. *Nursery methods.*—A study of some details of nursery management and their relation to horticulture in general. Lectures and reference readings.

7. *Spraying.*—The theory and practice of spraying plants, embracing a study of materials and methods employed in the combating of insects and fungus diseases. Recitations, reference readings, and laboratory work.

8. *Orcharding.*—A comprehensive study of pomaceous fruits—apple, pear, quince; drupaceous or stone fruits—plum, cherry, peach, nectarine, apricot. Each fruit studied with reference to the points enumerated under 2, above. Lectures, text-books, and laboratory work.

9. *Forestry.*—This course embraces a study of forest trees and their natural uses, their distribution, and their artificial production. The relations of forest and climate are studied, and the general topics of forestry legislation and economy are discussed.

10. *Landscape gardening.*—Ornamental and landscape gardening, with special reference to the beautifying of home surroundings. Lectures illustrated by means of lantern slides and charts, recitations, reference readings, and practical exercises.

11. *Economic botany.*—Useful plants and plant products. Lectures and assigned readings.

12. *Evolution of cultivated plants.*—Comprising a study of organic evolution and the modification of plants by domestication.

13. *Viticulture.*—A comprehensive study of the grape and its products.

14. *Nut culture.*—The cultivation and management of nut-bearing trees for commercial purposes.

15. *Floriculture.*—Amateur and commercial floriculture, including a study of window gardening, and the growing of cut flowers and decorative plants.

16. *General horticulture.*—For students not registered in the college of agriculture. A course covering the general principles and processes of fruit growing, gardening, floriculture, and ornamental planting.

17. *Commercial horticulture.*—A course giving practical training for those students intending to follow horticulture as a business. Work in houses, orchards, and gardens; suited to ability and requirements of each student. Special permission required for admission into this course.

18. *Experimental horticulture.*—A course for those intending to engage in professional horticulture or experiment-station work. For advanced students.

19. *Special investigations and thesis work.*—Required of candidates for graduation.

ANIMAL HUSBANDRY.

1. *Sheep, mutton, and wool.*—The comparative quality and value of mutton cuts; different grades of wool and their uses in manufactures, together with a critical examination of animals both for mutton, wool, and breeding purposes. The development and characteristics of the several breeds; the most successful methods of flock masters and the economic production of mutton and wool for the markets of the world. Lectures, assigned readings, and extensive practice in judging.

2. *Swine and their products.*—A study of the types and breeds of swine and the most successful methods of growing and marketing their products. Lectures, assigned readings, and practice in judging.

4. *Market classes, heavy horses.*—The horse market; an outline of the types and classes in demand; special study of the heavy horse; of the uses to which he is put and of the breeds suitable for his production, together with the best methods of producing and fitting heavy horses for market. Lectures, assigned readings, and exhaustive practice in judging.

5. *Market classes, light horses.*—Coach, carriage, and road horses; bus horses, cab horses, and saddlers; artillery and cavalry horses; a systematic study of their classes and types and of the breeds and methods most suitable for their production; also handling and fitting for market. Lectures, assigned readings, and practice in judging.

7. *Principles of stock feeding.*—The functional activities of the animal body and the end products of their metabolism. Foods are considered, first, chemically, as affording materials for the construction of the body tissues or animal products, as meat, milk, wool, etc.; second, dynamically, as supplying the potential energy for the body processes and for external labor; third, as to the fertilizing value of their residues.

8. *Stock breeding.* (See Thremmatology 1.)

9. *Investigation and thesis.*—Upon lines to be arranged with instructor for one or both semesters, according to nature of the subject.

10. *Meat.*—The various cuts of beef, mutton, and pork—their comparative food value, quality, and cost; a critical study of quality and richness in meat; the by-products of the slaughterhouse and their bearing upon the cost of meat. Lectures, assigned readings, and demonstrations.

11. *Market grades of beef cattle.*—An outline of the market types and grades, including prime steers, stockers, and feeders. A study of beef type from the standpoint of the butcher, the feeder, and the breeder. Lectures, assigned readings, and exhaustive practice in judging.

12. *Breeds of beef cattle.*—The history, development, and characteristics of the breeds suitable for beef production. Tracing pedigrees, and a critical study of the same. (This course is intended for students expecting to own or manage pure-bred herds.) Lectures, assigned readings, and exhaustive practice in judging.

13. *Beef production.*—Methods and practices in breeding and feeding beef cattle for the open market. By-products of the feed lot and their bearing upon the cost of beef. It is recommended that this course should be taken after Animal Husbandry 1. Lectures, assigned readings, and a study of experimental work.

14. *Management of pure-bred herds of beef cattle.*—Like Animal Husbandry 3, this course is intended for students anticipating the management or ownership of registered herds. The breeding herd, and its housing, feed, and management. The selection and fitting of animals for sale and for the show ring. Disposal of surplus stock. Lectures and assigned readings.

15. *Dairy cattle.* (See Dairy Husbandry 2 and 3.)

16. *Stable management and feeding.*—Stables; stable floors, fixtures and other equipment, and their care; feeding and care of work horses and drivers at labor and at rest; care of harness, vehicles, etc. Lectures and reference readings.

17. *The education and driving of the horse.*—A critical study of the mental qualities, peculiarities, and limitations of the horse, together with the most successful methods of educating and training him for skillful work at labor or on the road. The rules and practices of correct driving, the responsibilities of the driver, and the courtesies of the public highway. Lectures, readings, and practice.

18. *Breeds of light horses.*—Their history, development, characteristics, and uses. Lectures and assigned readings.

19. *Breeds of draft horses.*—Their history, development, and characteristics. Lectures and assigned readings.

20. *Breeding, rearing, and management.*—Selection of breeding stock; care and management of stallions, mares, and foals; buying, selling, and showing. Lectures and assigned readings.

DAIRY HUSBANDRY.

1. *Milk.*—The character and composition of normal milk; standardizing milk and cream; proper precautions to prevent contamination; the care and uses of milk; practice with the Babcock test and the lactometer, supplemented by lectures and reference readings and by laboratory experiments upon contamination of milk.

2. *Dairy cattle.*—The cow as a factor in the economic production of milk, butter, and cheese; difference in the efficiency of individual animals; establishment of the dairy herd by selection and grading with pure-bred sires; the principal characteristics of the dairy cow, with extensive practice in judging; the various breeds adapted to dairy purposes, their history and characteristics, with practice in judging by both dairy and breed standards.

3. *Dairy-farm management.*—Soiling and pasturing dairy cows; crops adapted to the dairy farm, and best methods of converting these into milk; the place and value of the silo on the dairy farm and the best methods of handling and feeding silage; a study of the best and most economical systems of feeding, together with the care and raising of calves; housing and general care of the herd; arrangement, ventilation, and care of dairy barn.

4. *Cream separation.*—A critical study of different systems of cream separation as to rapidity and efficiency, and the comparison of different machines, especially centrifugal separators; designed to be taken in conjunction with course.

5. *Butter making.*—Ripening the cream; churning, working, packing, and scoring the butter; designed to be taken in conjunction with course.

6. *Cheese making.*—Practice in setting milk, cutting and cooking the curd, and pressing and curing cheese. One-half of the time will be devoted to the manufacture of Cheddar cheese and the remainder to fancy cheeses, as Swiss, Edam, Gouda, cottage, etc.

7. *Factory management.*—Cooperative and company creameries and cheese factories; planning construction, equipment, and operation of plants, including care of engines, boilers, and refrigerating machines; a study of the construction and different insulations of creamery refrigerators, both for natural and mechanical means of refrigeration; also practice in pipe cutting and soldering.

8. *City milk supply.*—Sources of milk, together with methods of shipping, handling, and distributing, and of securing a healthful product for large cities.

9. *Comparative dairying.*—A study of the dairy systems and practice of different countries, including the care and management of dairy cattle. The principal dairy products of the different countries and the methods of handling and sale, particularly the preparation of milk for direct consumption. The more important conditions, historical and present, and local and inherited influences affecting dairy practices. Recitations, reference readings, and illustrated lectures.

10. *Dairy husbandry, minor.*—A study of the composition and variations of milk,

detection of adulterations by means of the Babcock test and lactometer; standardizing milk and cream; methods of detection of impure and unwholesome milk; where and to what extent milk becomes contaminated, and methods of prevention; scoring butter and cheese. This course is required for graduation of all students in agriculture who do not take more extended courses in dairy husbandry.

11. *Dairy bacteriology.*—A careful study of the distribution of bacteria as determined by a bacteriological analysis of air in the open field, dairy rooms, and dairy barns under different conditions, showing where and to what extent milk may become contaminated through the air and from the cow during process of milking and subsequently; also how this contamination may be largely avoided by proper methods. The effect of bacteria on milk and on the rapidity with which it sours after being produced under different degrees of cleanliness and held at different temperatures. The part that bacteria play in the ripening of cream and making of butter and in the manufacture and ripening of cheese.

12. *Investigation and thesis.*—Subject arranged with instructor.

13. *Fancy products.*—The manufacture of koumiss and primost and of different grades of ice cream. A study of the modifications of milk.

THREMMATOLOGY.

1. *Applied evolution.*—The principles of evolution as applied to the improvement of domesticated animals and plants. Variation, its extent and causes. Selection, and its effect in changing type, as illustrated both in nature and in domestication. The nature of heredity and the manner of its operation under the influence of environment. Reflex action, habit, and instinct, as bearing upon the question of the inheritance of acquired characters. The origin, correlation, and disappearance of characters. The laws of frequency and regression as bearing upon achievements that may be confidently expected.

2. *Investigation and thesis.*

VETERINARY SCIENCE.

1. *Anatomy and physiology.*—The anatomy and physiology of the domestic animals, diseases of the bony structure, and lameness. The instruction is given by lectures, aided by demonstrations with use of skeletons and of other apparatus, as follows: Dr. Auzoux's complete model of the horse, which is in 97 pieces and exhibits 3,000 details of structure; papier-maché model of the horse's foot, the teeth of the horse, and dissections of animals. This work is supplemented with the study of text-books.

2. *Veterinary materia medica.*—This subject, which treats of the agents for the cure of disease or injury, and for the preservation of health among domestic animals, is taught by lectures and text-books, illustrated by specimens of the drugs used in veterinary practice. The compounding of medicines also receives attention.

3. *Theory and practice of veterinary medicine and surgery.*—This subject is taught by lectures and text-books on the diseases of domestic animals, and is illustrated with specimens of morbid anatomy and by observations and practice at the free clinics. The latter are held at the veterinary infirmary once a week. The students assist in the operations, and thus obtain a practical knowledge of the subject. Dissections and post-mortem examinations are made as cases present themselves.

SECONDARY EDUCATION IN AGRICULTURE.

The movement for the establishment of secondary courses of instruction in agriculture has received a new impetus from the action of the State of Wisconsin in providing for the establishment of county agri-

cultural high schools. An account of the movement for the establishment of these schools in Wisconsin is given in the following paper by Prof. W. A. Henry, dean of the College of Agriculture of the University of Wisconsin:

SECONDARY AGRICULTURAL EDUCATION IN WISCONSIN.

The recent action of the Dunn County and the Marathon County boards in providing county agricultural schools is of such unusual importance to this Commonwealth that due cognizance should be taken of the same by all good citizens interested in educational advancement. The beginning of this movement reaches back many years. Sixteen years ago the regents of the University of Wisconsin becoming dissatisfied with the small attendance of bona fide agricultural students at the university, appointed a committee to consider the best means of bringing about a change. As chairman of that committee William F. Vilas prepared a report which was adopted by the board, and resulted in the establishment of what is now known as the short course in agriculture. The object of this course was to take young men directly from the farm and give them intensely practical training in agricultural lines, and then return them to the farm to make use of what they might have learned at the university. From an insignificant beginning this course of instruction has grown until it now has crowded the university accommodations to the utmost, with inability to accommodate all who seek instruction in some lines. To shut out nonresident attendance, the fees have been made practically prohibitory to those coming from other States.

Thoughtful educators and others interested in the intellectual development of our State have for some time past been impressed with the fact that it was simply out of the question for the university to attempt to provide instruction in elementary agriculture for all that needed such instruction, or even for those who might come to the university for that purpose. Thousands of young men should receive such training annually, and such numbers could not be accommodated at any one central point without incurring expense for such instruction entirely beyond the powers of the State to meet. Moreover, it is the function of the university to impart the highest form of instruction rather than to undertake elementary work in educational lines. Up to the present time there has been no place aside from the university where the young farmer could gain any training helpful in preparing himself for his future vocation. The city schools do not provide suitable training in many particulars for those who intend to live upon the farm. Urban educational effort is along urban lines toward urban conditions, and does not recognize in any way the vast fund of useful knowledge relating to the country and to country life. The farmer boy attending the village or city high school is being educated away from the farm rather than toward the farm, with all its possibilities for a useful life. To meet the wants of the large number of rural young folk who desire to secure some higher education than is afforded by the district school, and yet desire to keep in touch with farm life and farm conditions, some form of secondary agricultural schools seems imperative.

To understand the subject historically in Wisconsin, it is necessary at this point to take up another line of educational effort. We have in our State seven normal schools, with an attendance of about 2,200 pupils. Great as is this number, it is unfortunate to report that the graduates of these schools have not to any extent gone into the rural schools as teachers. Even those who leave the normal schools before graduation do not supply in any large measure the demands for trained teachers made by the country schools. As a consequence the 5,000 rural schools in Wisconsin have been largely without specially trained teachers in the past. There recently arose the thought of establishing county training schools for teachers, and the Wisconsin

legislature of 1899 enacted a law permitting two counties, but not more, to found county training schools for teachers and provided that if these fulfilled certain requirements they should each be allowed to draw $1,250 annually from the State treasury. Marathon and Dunn counties were the first to apply for the benefits of this act and thereby secured the State appropriation. From their inception these schools have been a success in training teachers who afterwards teach in the country district schools. So pleased was the State at the success of the two-county training schools for teachers that the legislature of 1901 doubled the State allowance, making it $2,500 annually to each school, and authorized the establishment of four additional county training schools for teachers, making the number allotted six in all. Six such schools are now in operation. The legislature of 1901 further provided that after that year all school-teachers should be examined in the elements of agriculture.

The reader who may have followed this presentation thus far will readily see how naturally and easily the next step in our educational development has been taken. The overcrowded condition of the college of agriculture at the university in its elementary work, the wonderful success of the novel idea of county normal schools for rural teachers and the requirements of examination of all teachers in the elements of agriculture have brought us forward to a point where a further move is essential to the rounding out of a rational system of education for our Commonwealth.

In December, 1898, State Superintendent L. D. Harvey, in a paper before the State Teachers' Association in Milwaukee, brought to the attention of educators the subject of county agricultural schools. The legislature of 1899 directed the superintendent of public instruction to investigate and report upon the methods of instruction in manual training and the theory and art of agriculture in other countries and States. Superintendent Harvey's report on this matter covers 83 pages of interesting data. Everything was now ready for the final move, which was made without serious difficulty, there being a surprising agreement of our legislators as to its necessity and expediency. Superintendent Harvey prepared a bill providing for the establishment of county schools of agriculture and domestic science. A digest of the law (chapter 288, Laws of 1901) is as follows:

Section 1. The county board of any county is authorized to establish and maintain "a county school of agriculture and domestic economy."

Section 2 provides for a county school board to control such school.

Sections 3 and 4 provide for two counties to unite in a joint agricultural school.

Section 5 makes the county treasurer the ex-officio treasurer of the board.

Section 6. In all county schools of agriculture and domestic economy organized under the provisions of this act, instruction shall be given in the elements of agriculture, including instruction concerning the soil, plant life, and the animal life of the farm; a system of farm accounts shall also be taught; instruction shall also be given in manual training and domestic economy, and such other subjects as may be prescribed.

Section 7. Each such school shall have connected with it a tract of land suitable for purposes of experiment and demonstration, and not less than 3 acres in area.

Section 8. The schools organized under the provisions of this act shall be free to inhabitants of the county or counties contributing to their support, who shall be qualified to pursue this course of study, provided they shall have at least the qualifications required for completion of the course of study for common schools. Whenever students of advanced age desire admission to the school during the winter months in sufficient number to warrant the organization of special classes for their instruction such classes shall be organized and continued for such time as their attendance may make necessary.

Section 9 provides that the State superintendent shall render assistance, and, "with the advice of the dean of the college of agriculture of the State University," he shall prescribe the courses of study to be pursued and determine the qualifications required of the teachers employed in such schools.

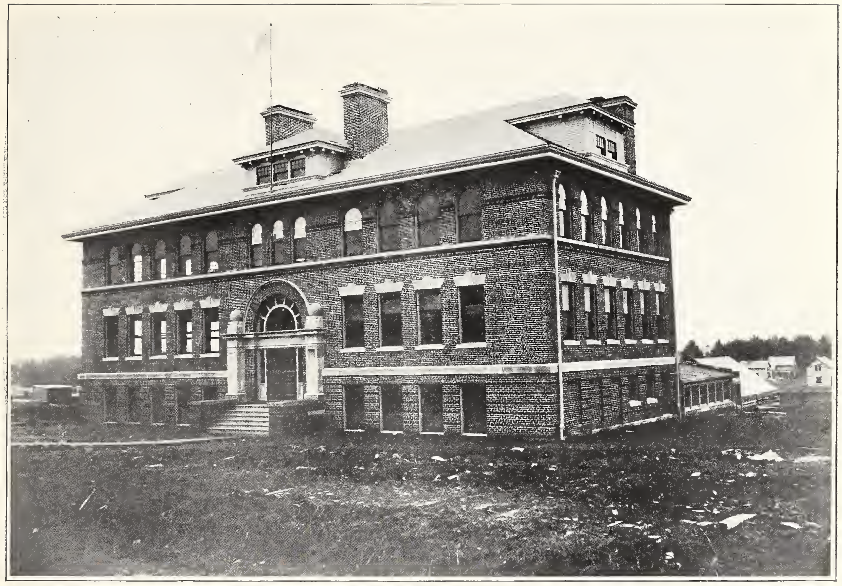


FIG. 1.—AGRICULTURAL EDUCATION—NEW MAIN BUILDING OF THE MARATHON COUNTY SCHOOL OF AGRICULTURE AND DOMESTIC ECONOMY.

FIG. 2.—AGRICULTURAL EDUCATION—NEW MAIN BUILDING OF THE DUNN COUNTY SCHOOL OF AGRICULTURE AND DOMESTIC ECONOMY.

Section 10 provides that a school complying with the provisions of the law may be placed on the approved list of county schools of agriculture and domestic economy. The secretary of such school shall report annually the condition of the school to the State superintendent, setting forth the cost of the school, character of the work done, number of teachers employed, etc. If the State superintendent is satisfied that the school is up to grade, he shall certify the same to the secretary of state, who shall pay over to such school a sum equal to one-half the amount actually expended for instruction in such school, provided that the total amount so expended shall not exceed $5,000 in any one year. But two schools can draw State aid under this act.

This allows a sum not exceeding $2,500 to be turned over by the State to each of the two county schools allowed under this act.

Marathon and Dunn, the two counties which were first to have county teachers' training schools under the law of 1899, are the first to avail themselves of the law above summarized. When it is known that both these counties are located in the newer parts of our State, it will be realized that "push and progress" is the watch-word of these ambitious people. Having learned from direct observation the merits of county normal schools, these counties have gone a step further and completed their educational system by arranging for county schools of agriculture and domestic economy.

The Marathon County School of Agriculture and Domestic Economy, located at Wausau, Wis., was opened October 6, 1902. (Pl. XLIII, fig. 1) The buildings and equipment provided for this school cost $20,000. The school grounds cover 6 acres. The course of study for boys includes soils, plants, animal husbandry, rural architecture, blacksmithing, carpentry, and mechanical drawing. The course of study for girls includes cooking, laundering, sewing, floriculture, and home management and decoration. Both courses include English language and literature, United States history, civil government, and commercial arithmetic with farm accounts. Tuition is free to students living in Marathon County. The cost of board and rooms runs from $2.50 to $3. On November 26, 1902, this school was reported to have 62 students—15 boys and 47 girls. The average age of the students was 16 years. The principal of the school is R. B. Johns, a graduate of the University of Wisconsin.

The Dunn County School of Agriculture and Domestic Science is located at Menomonie. (Pl. XLIII, fig 2.) This school is centrally located in the county and is equipped with a fine brick main building, erected by the county at a cost of $16,000, for the joint use of this school and the county teachers' training school, and a frame building for shopwork, which, with grounds surrounding the school, cost $5,000. The farm work is done on the county asylum farm 1 mile distant from the school.

The course of study for boys includes instruction regarding soils, fertilizers, plant life, horticulture, field crops, animal husbandry, dairying, poultry, economic insects, farm accounts, blacksmithing and other metal work, carpentry, and rural architecture.

The course of study for girls includes work in sewing, cooking, home economy and management, drawing and designing, domestic hygiene, chemistry of foods, dairying, poultry, farm accounts, and horticulture.

Both courses include studies in United States history, civil government, library readings, English, and elementary science.

Only two years will be required to complete the full course for either boys or girls, and shorter courses may be pursued.

Tuition is free to students living in Dunn County. Others will pay $25 per year, except that the first ten students from other counties will be admitted for the first year on the payment of only $10 each.

Students may find board and rooms in private families in Menomonie at prices ranging from $2.25 to $3.75 per week. Students can board themselves for about $2 per week.

The school opened October 20, 1902, and by December 44 students had registered—32 boys and 12 girls—of an average age of 18½ years. This number has since

increased. They are from country schools, with few exceptions. The principal of the school is Dr. K. C. Davis, a graduate of the Kansas Agricultural College and recently horticulturist at the West Virginia Agricultural Experiment Station.

State Superintendent Harvey, who has watched both these efforts from the beginning, and to whose credit the conception of the county agricultural schools in Wisconsin must ever stand, states that there will be required in the county training school for teachers 2 teachers and in the county agricultural school 3 teachers as a minimum. In the agricultural school there will be needed 1 principal, who will teach branches of agriculture, 1 teacher of manual training, 1 teacher of domestic economy. Each will teach some academic branch in addition.

As all teachers in the rural schools must now pass examination in the elements of agriculture, it will be seen that the union of these two branches of education in one school is a wise one. Mr. Harvey states that pupils from the rural schools who have completed the course of study provided for such schools will doubtless be admitted to these agricultural schools; that their training here should be covered in a two years' course.

If the experiments in Dunn and Marathon counties prove successful, no doubt other counties will likewise establish county agricultural schools, and the system will gradually spread over the State. The wisdom of experimenting with the county training school system by allowing only two schools at first and later following along the same lines for agricultural schools is to be highly commended. The State is experimenting along the best lines of educational effort, and the people are gradually being educated to new and important changes, which, if wrought too suddenly, might bring dissatisfaction and revulsion.

If the system of county agricultural schools shall gradually extend over the State, the time is not far distant when there can be a material rise in the grade of scholarship required for the admission of short-course students to the university. When this comes about, the university will receive graduates from the county agricultural schools and give to such advanced agricultural training. It will relegate to the county schools much of the elementary work which it is now doing. Among its other functions, it will prepare teachers for the county agricultural schools and give to such young men as wish a higher degree of agricultural training than they can secure in the county schools.

The farmers' sons and daughters will now have near at home schools specially devoted to their interests, helpful to them in their future farm life. In the judgment of the writer, the addition of county training schools for teachers and county agricultural schools rounds out our educational system in Wisconsin in a symmetrical and complete manner. No class of people or interests in the State are longer left uncared for educationally. City children are educated in their way for the city, and country children are educated for country life. Much remains, of course, to be done in the way of perfecting the system, but the main lines are now properly laid. Wisconsin is the first State in the Union to provide for secondary agricultural education by a system of county schools specially designed to meet the needs of farmers' sons and daughters.

AGRICULTURAL COURSES IN TOWN HIGH SCHOOLS.

To aid in the movement for the organization of secondary courses in agriculture, the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiment Stations made a report on this subject to the convention of the associa-

tion, held at Atlanta, Ga., in October, 1902. That portion of this report which relates to the public high schools is given below:

In addition to provision for instruction in agriculture in connection with the colleges and in special agricultural high schools the teaching of agriculture should be introduced into the public high schools in or near the rural communities. There are many villages and cities in the United States which are dependent on the farms surrounding them for their commercial prosperity, if not for their very existence. The high schools maintained in these places draw their students largely from the farms. There is good reason why communities of this kind should seek through their schools to promote the interests of the industry to which they owe so much. They should at least cooperate with the surrounding rural communities to secure for the farmers' children technical education in agriculture parallel to the education in commercial business and mechanic arts which many of the city high schools are now offering to their students.

As previously stated, the high-school system of the United States has been rapidly developed in the past few years in the direction of broadening the courses in natural science and industrial arts and in the provision for numerous elective courses in these and other subjects. While it continues to supply college preparatory courses for the limited number of students intending to pursue their school career beyond the high school, its chief business is to educate the nine out of every ten of its students who are to step from its halls into active life. In our largest and wealthiest cities this change of aim of the high school has led to the establishment not only of numerous courses in the classics, modern languages, natural sciences, mathematics, history, and political economy, but also of separate high schools with elaborate courses in business forms and mechanic arts. The smaller cities are striving to follow in the same path as far as their means will permit.

Agriculture has thus far been almost entirely neglected in the high-school programmes, and it is high time that the friends of agricultural education should make a systematic effort to have the claims of this fundamental industry acknowledged and satisfied in the curricula of the public high schools. Since successful agriculture is essential to the prosperity and well-being of urban as well as rural communities, there should be cooperation between country districts, villages, cities, and the States to provide the means for the maintenance of agricultural courses in the high schools. As a practical measure it is believed that such courses may be added to those already existing in many high schools by the addition of a single teacher, who should be an agricultural college graduate, to the teaching force already supplied. The expense of maintaining this teacher and his equipment may properly be shared by the State, the village, or city maintaining the high school, and the country district from which the pupils from the farms are drawn to this school. The State may properly aid this movement by offering a stated sum annually to high schools maintaining agricultural courses. Already many small townships are paying the tuition of pupils attending high schools in neighboring townships, and this system should be extended with the proviso that such tuition fees paid for students desiring agricultural courses should be devoted to the maintenance of agricultural courses. The balance necessary to maintain these courses will, it is believed, be cheerfully paid by the villages or cities maintaining the high schools as soon as they realize that such expenditure is in the nature of an investment, the returns from which in the way of better and more abundant agricultural products will be certain and remunerative.

In order that it may be apparent that agricultural courses may be offered in the high schools without any violent or radical reorganization of existing programmes

for such schools, a number of tentative schedules for such courses are presented herewith along with various courses already existing in high schools in different parts of the country. An examination of numerous high-school programmes has revealed a very great variety in their courses as regards the number of different branches and the amount of time devoted to each branch in any particular course. In general, however, it may be said that the average high-school course in this country presupposes that the student has had an eight-year course in a primary school, where he has been taught reading, writing, spelling, arithmetic, elements of English grammar and composition, geography, and United States history. The best primary schools also give some instruction in drawing, music, nature study, and woodworking, or sewing and cooking.

The high-school course covers four years and will ordinarily embrace instruction in algebra, geometry, ancient and modern history, English, drawing, and music, together with various combinations of Latin, Greek, French, German, and the elements of natural sciences (especially chemistry, physics, and botany). Whenever the manual arts or the natural sciences are largely introduced into high-school courses the practical effect is to reduce the amount of time given to the ancient and modern languages. With improved instruction in English and science the effect of this on the general training of the student is not as marked as it might otherwise be, and whatever the theoretical pedagogical value of instruction in ancient or modern languages, there is little doubt that when a choice has to be made between these subjects and those which relate directly to the pursuit by which the pupil is to gain his livelihood, it will in most cases be desirable that he shall choose the things of most direct benefit in his life work. That it will not always be necessary for the student of agriculture to entirely neglect the study of at least one ancient or modern language in this high-school course, provided his tastes or attainments lead him in that direction, may be seen from examination of the programmes of courses presented herewith.

With the introduction of agriculture into the high-school course, it is presumed that the courses in physics, chemistry, botany, and zoology will be so shaped as to form an appropriate introduction to the more formal instruction in the different branches of agriculture, i. e., agronomy, zootechny, dairying, rural engineering, and rural economy. As indicated in previous reports of this committee, we would include under agronomy whatever is taught regarding climate, soils, fertilizers, and the botany, varieties, culture, harvesting, preservation, uses, and enemies of farm crops; under zootechny, the theory and practice of animal production, including the breeding, feeding, hygiene, and management of farm animals; under dairying, the principles and methods involved in the handling and sale of milk for consumption and in the making of butter and cheese; under rural engineering, principles and methods involved in the laying out of farms, and the construction and use of farm buildings, systems for water supply, irrigation, drainage, sewerage, roads, and machinery; under rural economy, the history of agriculture, capital, labor systems, cost of production, marketing, records, accounts, etc., as related to farm management.

Beginning with the simpler forms of high-school courses, we present a programme prepared under direction of the State superintendent of public instruction in Indiana and recommended for use in that State in high schools where at least two teachers are employed exclusively in high-school work, and along with this a tentative agricultural course prepared by your committee, which presupposes an additional teacher.

Programme for high schools in Indiana.[a]

FIRST YEAR.

General course.		Tentative agricultural course.	
Algebra	5	English	5
English	5	Algebra	5
Latin	5	Plants and their cultivation (i. e., botany—general and economic)	5
Physics or chemistry	5	Physics	5

SECOND YEAR.

Algebra (one-third year)	5	English	5
Geometry (two-thirds year)	5	Algebra Geometry	5
English	5	Animals and their management (i. e., zoology—general and economic)	5
Latin	5	Chemistry	5
History	5		

THIRD YEAR.

Geometry (two-thirds year)	5	English	5
Elective[b] (one-third year)	5	Geometry, Latin, or German	5
English	5	Agronomy (with special attention to local crops)	5
History	5	History	5

FOURTH YEAR.

Elective[b]	5	History	5
Zoology or botany	5	Political economy	5
Latin	5	Zootechny and dairying	5
History	5	Latin or German	5

[a] With each subject the number of recitation periods per week is given.
[b] Mathematics, physical geography, oratory, or advanced physiology.

With the introduction of agriculture into high schools of this kind the division of studies among three teachers might be as follows:

A.	B.	C.
English. Latin. German.	Chemistry. Botany. Zoology. Agriculture.	Physics. Mathematics. History. Political economy.

Teacher B should be an agricultural college graduate and would ordinarily be a man who might be principal of the school. Teachers A and C would ordinarily be women.

As an example of a high school in a city of medium size, that of Lowell, Mass. (population, 95,000; chief industry, cotton manufacturing), has been selected.

Eight courses are offered, but only the classical, modern language, and manual-training courses, recommended as general training courses, are given herewith. Studies in italics are elective.

Programme of Lowell (Mass.) High School.[a]

FIRST YEAR.

Classical course.		Modern-language course.		Manual-training course.		Tentative agricultural course.	
English	5	English	5	English	5	English	5
Algebra	5	Latin	5	Algebra	5	Algebra	5
Latin	5	Algebra	5	Manual training	5	Plants and their cultivation (i. e., botany—general and economic)	5
Physical geography	2½	*Physical geography*	2½	*Physical geography*	2½	Physics	2½

SECOND YEAR.

Classical course.		Modern-language course.		Manual-training course.		Tentative agricultural course.	
History and English	5	History and English	5	History and English	5	History and English	5
Geometry	5	Physics	5	Manual training	5	Animals and their management (i. e., zoology—general and economic)	5
Physics	5	*Geometry*	5	*Geometry*	5	*Chemistry*	5
Latin or *French*	5	*French*	5	*Physics*	5	*Geometry*	5
				French	5	*French* or *German* or *Latin*[c]	5

THIRD YEAR.

Classical course.		Modern-language course.		Manual-training course.		Tentative agricultural course.	
History and English	5	History and English	5	History and English	5	History and English	5
Arithmetic	2½	*Arithmetic*	2½	Manual training	5	Agronomy and rural engineering	5
Physiology	2½	*Physiology*	2½	*Arithmetic*	2½	*Arithmetic*	2½
Chemistry	2½	*Chemistry*	2½	*Physiology*	2½	*Physiology*	2½
German	5	*German*	5	*Chemistry*	5	*Chemistry*	5
Latin	5	*French*	5	*German*	5	*French* or *German* or *Latin*[c]	5
Astronomy and *geology*[b]	5	*Astronomy* and *geology*[b]	5	*French*	5	*Astronomy* and *geology*[b]	5
				Astronomy and *geology*[b]	5		

FOURTH YEAR.

Classical course.		Modern-language course.		Manual-training course.		Tentative agricultural course.	
English	5	English	5	English	5	English	5
History	5	*History*	5	Manual training	5	Zootechny and dairying	5
Chemistry	5	*Chemistry*	5	*History*	5	*History*	5
German	5	*German*	5	*Chemistry*	5	*Rural economy* and *farm management*	2½
Latin	5	*Botany*	2½	*German*	5	*Entomology*	2½
Botany	2½			*French*	5	*Trigonometry* and *surveying*	5
				Geometry and *trigonometry*	5	*French* or *German* or *Latin*[c]	5

[a] With each subject the number of recitation periods per week is given.
[b] May be taken the fourth year instead of the third.
[c] Whatever language is elected should be continued through at least two years.

Another example of a high school in a city of medium size has been selected, viz, Des Moines, Iowa (population, 62,000), which is in the midst of a rich agricultural district. This illustrates a course of study in which the elective system predominates. By simply adding to the curriculum for the second, third, and fourth years electives in agriculture a course of study much better adapted to the needs of pupils from the rural districts could be arranged.

Programme of Des Moines (Iowa) High School.[a]

FIRST YEAR.

Present course of study.		Tentative agricultural course.	
Algebra	5	Algebra	5
Zoology	2½	Zoology	2½
English	3	English	3
Drawing	2	Drawing	2
Botany	2½	Botany	2½
Latin	5	*Latin*	5
Phgsical geography	2½	*Physical geography*	2½
Geology	2½	*Geology*	2½

SECOND YEAR.

Algebra	2½	Algebra	2½
Geometry	2½	Geometry	2½
English	2½	English	2½
History	5	History	5
Physiology	2½	*Physiology*	2½
Latin	5	*Plants and their cultivation* (i. e., botany—general and economic)	2½
Bookkeeping and *commercial law*	5	*Animals and their management* (i. e., zoology—general and economic)	2½
		Latin	5
		Bookkeeping and *commercial law*	5

THIRD YEAR.

Geometry	5	Geometry	5
English	5	English	5
Latin	5	*Agronomy* and *rural engineering*	5
Greek	5	*Latin*	5
German	5	*Greek*	5
French	5	*German*	5
Chemistry	5	*French*	5
Civics and *economics*	5	*Chemistry*	5
English history	2½	*Civics* and *economics*	5
American history	5	*English history*	2½
		American history	5

FOURTH YEAR.

Physics	5	Physics	5
English	5	English	5
Latin	5	*Zootechny* and *dairying*	5
Greek	5	*Rural economy* and *farm management*	2½
German	5	*Latin*	5
French	5	*Greek*	5
Civics and *economics*	5	*German*	5
American history	5	*French*	5
Trigonometry	2½	*Civics* and *economics*	5
Astronomy	2½	*American history*	5
		Trigonometry	2½
		Astronomy	2½

[a] With each subject the number of recitation periods per week is given. Each pupil must take studies occupying at least 15 periods in addition to English. Subjects in *italics* are elective.

As an example of a high school in a large city, that of Washington, D. C. (population 279,000), has been selected. In this city there are also business and manual-training high schools with elaborate special courses. For our present purpose the tentative agricultural course is compared with the courses offered in the general high school.

Programme of Washington High School.[a]

FIRST YEAR.

Academic course.		Scientific course.		Tentative agricultural course.	
English	5	English	5	English	5
History	5	History	5	Algebra	5
Algebra	5	Algebra	5	Plants and their cultivation (i. e., botany—general and economic)	5
Latin	5	German	5	Physics	5
Drawing		Drawing		Drawing or woodworking	

SECOND YEAR.

English English history	5	English English history	5	English	5
Greek	5	Geometry	5	Geometry	5
Geometry	5	German or French	5	Animals and their management (i. e., zoology—general and economic)	5
Latin	5	Physics or chemistry	5	Chemistry	5
Physics or chemistry	5	Drawing		Drawing or woodworking	
Drawing					

THIRD YEAR.

English	5	English	5	English	5
Latin	5	German or French	5	History	5
French	5	*Biology*, or *advanced chemistry*, or *advanced physics*	5	Agronomy and rural engineering	5
German	5	*French*	5	*Biology*	5
Greek	5	Political economy	5	*Trigonometry* and *surveying*	5
Biology, or *advanced chemistry*, or *advanced physics*	5	Solid geometry	5	*Latin*	5
Political economy	5	*Trigonometry* and *surveying*, or *history*	5	*German*	5
Solid geometry	5			*Bookkeeping*	5
Trigonometry and *surveying*, or *history*	5			*Drawing*	5

FOURTH YEAR.

English	5	English	5	English	3
Latin	5	German or French	5	Political economy	5
Advanced biology, or *chemistry*, or *physics*	5	Advanced biology, or *chemistry*, or *physics*	5	Zootechny and dairying	5
Greek	5	*History*, or *analytical geometry* and *college algebra*	5	Rural economics and farm management	2
History, or *analytical geometry* and *college algebra*	5	*French*	5	*History*	5
French	5	*Spanish*	5	*Latin*	5
German	5			*German*	5
Spanish	5			*Drawing*	5
				Bookkeeping	5
				Entomology	5

[a] With each subject the number of recitation periods per week is given. Each candidate for a diploma must take studies occupying at least 20 periods, except in the fourth year, when the minimum requirement is 18 periods. Subjects in *italics* are elective.

It is believed that the presentation of schedules as above justifies the assertion that it is entirely practicable to adjust an agricultural course of high-school grade to existing high-school schedules and to make this agricultural course fairly satisfactory for the purposes of general training, as well as elementary instruction in the theory and practice of agriculture. The graduate of such an agricultural course may fairly be expected to understand the scientific basis of improved agriculture and to have an intelligent appreciation of the needs of a progressive agriculture. He will then be in position to profit by the results of the investigations of the experiment stations and by the information regarding the progress of his art which may come to him from the more intelligent of his neighbors, farmers' institutes, and good books and journals. He will be likely to become an intelligent and progressive farmer as well as a refined and useful citizen and home-maker.

In the present condition of secondary education in this country there is no room for dogmatism regarding courses of study, but there is every reason why the friends of agricultural education should assert their right to be heard in claiming the importance, desirability, and feasibility of including instruction in agricultural subjects in high-school programmes. Your committee has proceeded on the assumption that the definite formulation of tentative secondary courses in agriculture would contribute to the more intelligent discussion of this important subject. If continued, it may hereafter give more attention to this subject and report such further suggestions as more extended study may bring out.

A. C. True,
T. F. Hunt,
H. T. French,
H. H. Wing,
Committee.

FARMERS' INSTITUTES IN THE UNITED STATES.

By D. J. Crosby.

GENERAL SURVEY OF THE INSTITUTE MOVEMENT.

In the Annual Report of the Secretary of Agriculture for 1901 Congress was asked to make an appropriation of $5,000 to enable this Department through its Office of Experiment Stations to undertake the work connected with the promotion of the farmers' institute system in this country. The appropriation was to be used in employing an officer who would devote his time and energy to this work, visit institute workers and advise with them regarding the ways in which the Department might help the institutes, study the problems of institute management at home and abroad, and seek to shape the Department's work for the institutes so that it might be most helpful to this enterprise. Some of the ways in which the Department might help the institutes were pointed out as follows: (1) By collating and publishing information regarding the institute movement at home and abroad; (2) by furnishing the institute workers with the Department publications and information through correspondence; (3) by advising and assisting institute managers with reference to perfecting organization and strengthening the work in weak places; (4) by sending out lecturers to address representative institutes in different States on the work of the Department; (5) in general, by acting through its Office of Experiment Stations as a sort of clearing house for the farmers' institute movement as it has done in the case of the agricultural experiment stations—that is, it would be a center for the focalization and dissemination of information and influences which would serve to develop farmers' institutes and make them a more efficient means for the education of our farmers and the improvement of our agriculture.

As the matter was finally arranged in the appropriation act, only about $2,000 of the income of this Office for the current fiscal year could be used for the promotion of the institutes. This sum was entirely inadequate for the work planned, but a part of it has been used in publishing the proceedings of the American Association of Farmers' Institute Workers (Bulletin 120 of this Office) and in gathering statistics of the institute movement. The remainder of the appropriation will be used in employing during a portion of the year an officer who will investigate the problems of institute management

and will be retained as the farmers' institute specialist of this Office if Congress shall provide sufficient means for continuing the work.

At the seventh annual meeting of the American Association of Farmers' Institute Workers, a brief account of which is given on page 51, the plans of this Office for aiding the farmers' institute movement were explained to the members, who unanimously adopted a resolution cordially approving the plans.

From brief reports given at this meeting by delegates from the 24 States represented, it appears that one of the most troublesome problems confronting the institute managers is how to secure competent institute workers. The demand is for institute workers having a wide range of knowledge regarding the science and practice of agriculture and particularly up-to-date information regarding the progress that is being made throughout the world in studying problems in agriculture both at the experiment stations and on the farm. Such men are relatively scarce, except among the officers of our agricultural colleges and experiment stations, whose other duties are in most cases so exacting that they can not be expected to devote much time to institute work. There is need of developing a class of institute workers who shall combine successful practical experience and scientific knowledge of agriculture with the ability to address large audiences of farmers in a way not only to hold their attention, but also to impart to them definite information and instruction. This involves the creation of a corps of institute workers who shall receive sufficient salaries to induce them to make specific preparation for their work and to enable them to keep the information in their addresses up to date by studies pursued from year to year. In the task of developing and training these men the Department can help by furnishing them with the Department publications and information through correspondence. This is already done to a considerable extent, but may be more efficiently and thoroughly done by having in the Department a regular agency for this work. The institute workers would undoubtedly appeal to the Department with much more freedom if they felt that their work was definitely recognized here, as is the case with the agricultural colleges and experiment stations. They should also be made to understand that they are very welcome to come to the Department, and by residence at Washington for a longer or shorter time have opportunities for acquiring information through personal contact with the officers of the Department, the use of its library, etc.

It also appeared at this meeting that there is a demand for lecturers from this Department to address representative institutes in different States on the work of the Department, and this demand has since been emphasized by a number of requests for such speakers. Thus far the Department has trusted very largely to its publications for the dissemination of the information which it gathers, and which has grown

to be very large in extent and variety. It would hardly be practicable for the Department to be represented in a single year at any considerable number of institutes in any one State or Territory, but it is believed that more might be done to bring the work of the Department directly to the attention of the leaders in this enterprise through the attendance of its officers at representative meetings, which might be held from time to time in the different States under such conditions as would bring together relatively large numbers of farmers. In this way the influence of the Department would be extended and its officers would have opportunities which they now lack for finding out what the farmers really desire to have the Department do for their benefit. An organization in the Department to promote this work would undoubtedly make it possible for the Department to do much more in this direction.

Returns from the 43 States and Territories in which institutes are held show how far-reaching would be any influence affecting their development to any considerable extent. The number of meetings held annually in the different States and Territories varies from 1 each in Nevada and Rhode Island to more than 250, Michigan holding 255, New York 269, and Ohio 278, including 26 independent institutes. The total number of institutes held during the past year was over 2,700. The time covered by each meeting varies from a single session of a few hours to five or six sessions. There are also held in some States annual round-up meetings at accessible points, which are in session from two to five days, and are attended usually by most of the institute staff, for whom the round-up becomes an inspiration meeting and training school. The total number attending institutes in the United States last year was approximately 819,000, which is eighty times the number of students taking regular courses in agriculture, dairying, veterinary science, and household economy in our land-grant colleges, and nearly twenty times the number enrolled in all departments of those colleges, either in regular or special courses, in collegiate or post-graduate courses. And yet the whole number of people reached by both the institutes and the agricultural colleges is only a small percentage (8.4 per cent) of those actually engaged in agricultural pursuits in this country. The colleges, from their very nature, are not capable of indefinite expansion; their influence is necessarily restricted largely to the younger men and women, to those who will be the farmers of the future. To meet the needs of the present for the broad dissemination of reliable agricultural information among practical farmers, no better agency has been found than the farmers' institutes. It is important, therefore, that the efforts of local authorities to extend the scope and influence of farmers' institutes be supplemented by well-directed and concerted efforts by some central agency, such as the United States Department of Agriculture.

Large sums of money are expended annually in conducting farmers' institutes, the aggregate being about $163,000, not including expenses incurred by local authorities, which in some States amount to several thousand dollars per annum. However, the manner of raising institute funds in the different States and Territories differs greatly, as do also the amounts raised. In twenty-five of the States and Territories no special appropriations for institutes are made, the funds for this work being taken from funds provided for the support of the agricultural colleges, experiment stations, or State boards of agriculture. In three of the States and Territories making provision for institutes the appropriations do not exceed $1,000, in twelve they range from $1,000 to $5,000, in one $10,000, in one $12,000, in one $15,000, and in four they are above $15,000. Thus it appears that in more than half of the States and Territories no regular provision for institutes is made, and that in many more the funds devoted to this work are so meager as to be out of all proportion to the importance of the agricultural interests involved or to the number of people engaged in farming. In most of these localities some effort to develop institute work has been made by those interested in bettering agricultural conditions, and it is also true that in some Commonwealths where no appropriations for institutes are made relatively large sums have been devoted to the work; but with no specific appropriations for institutes the amount of money devoted to such work in any given case depends largely upon the inclination of the officials charged with the expenditure of the money. The result in the localities where no regular provision for institute work has been made is a very slow and imperfect development of the work. If this Department were in a position to lend such assistance that a general interest in institute work could be aroused among the farmers in these sections and the way to secure the institutes pointed out, it is reasonable to assume that funds for the more liberal and regular support of the movement would soon be furnished.

The systems of institute management are various. In twenty-one of the States and Territories institutes are conducted under the auspices of State boards or departments of agriculture; in eighteen they are under the control of college or station authorities, and in the remainder they are poorly organized or are under the dual control of educational institutions and State officials. In relatively few cases are there strong organizations developed for the special purpose of conducting farmers' institutes. This Department, through its Office of Experiment Stations, will, if Congress provides the necessary funds, assist in this work of organization in the same way that it has helped the experiment stations throughout the country. The visits of the officers of the Department to the different experiment stations and the conferences held at Washington and at the meetings of the Association of American Agricultural Colleges and Experiment Stations have, it is believed, done much to systematize the work of the stations and make them more

efficient. In a similar way an institute specialist from this office might visit the managers of institutes and the institutes themselves in different States and Territories, and meet representative institute managers at Washington, or in conferences held in different parts of the country. Already there is a successfully conducted American Association of Farmers' Institute Workers, which may easily be developed so as to become a very important factor in the further progress of the farmers' institute movement.

FARMERS' INSTITUTES IN THE SEVERAL STATES AND TERRITORIES.

The following brief statements regarding farmers' institutes include facts relating to their organization, their financial support, the number held, the approximate attendance, and the manner of publishing and distributing proceedings. In some of the States where the institutes are not thoroughly organized there is no special institute director or superintendent, the duties of this position devolving upon some member of the agricultural college or experiment station staff or upon an officer of the State board or department of agriculture.

ALABAMA.

C. A. Carey, Veterinarian Alabama Polytechnic Institute and Agricultural Experiment Station, *Auburn.*

In Alabama farmers' institutes are held under the auspices of the Alabama Polytechnic Institute at Auburn. The staff, consisting of about eight members, is made up mostly of members of the college and station staff. For the support of institutes $400 is appropriated from the fees for fertilizer inspection and $200 from the Hatch fund. During the past year 24 one-day institutes were held, with an attendance of about 2,600. Institute proceedings are not published.

G. W. Carver, Director Agricultural Department of Tuskegee Normal and Industrial Institute, *Tuskegee.*

For the colored race in Alabama monthly conferences of farmers are held at the Tuskegee Normal and Industrial Institute; also an annual conference which is attended by a large number of farmers from all parts of the State.

ARIZONA.

R. H. Forbes, Director Agricultural Experiment Station, *Tucson.*

No regular organization for holding farmers' institutes exists in Arizona. During the past year two institutes held under the auspices of the University of Arizona were attended by about 350 people. Four members of the experiment station staff took part in these institutes.

ARKANSAS.

Farmers' institutes are not organized in Arkansas.

CALIFORNIA.

E. J. WICKSON, Superintendent Farmers' Institutes, *Berkeley.*
D. T. FOWLER, Conductor of Institutes in Central and Northern California, *Berkeley.*
A. J. COOK, Conductor of Institutes in Southern California, *Claremont.*

The department of university extension in agriculture of the University of California holds the farmers' institutes. The professor of agricultural practice in the university is superintendent. He delegates the direct management of the institutes to two conductors, one for central and northern California and the other for southern California. The regular institute staff comprises nine speakers, who are assisted by local speakers. A college appropriation of $4,000 provides for traveling expenses and per diem, but expenses for rent of halls, printing programmes, and advertising the institutes are paid by the localities in which institutes are held. During the past year 63 institutes were held, the total attendance being about 20,000.

COLORADO.

B. O. AYLESWORTH, President State Agricultural College, *Fort Collins.*

Farmers' institutes in Colorado are held under the auspices of the State Agricultural College of Colorado, with a staff of some 25 members, nine of whom are officers of the college and station. There is no State appropriation for this work, each institute providing the funds to pay all local expenses. The necessary expenses of college and station men who participate in the work are paid from college funds. During the past year 9 one-day and 6 two-day meetings were held. No proceedings are published.

CONNECTICUT.

JAMES F. BROWN, Secretary State Board of Agriculture, *North Stonington.*
GEORGE E. MANCHESTER, Secretary Connecticut Dairymen's Association, *Winsted.*
H. C. C. MILES, Secretary Connecticut Pomological Society, *Milford.*

The farmers' institutes in Connecticut are held under the auspices of the State board of agriculture, the State Dairymen's Association, and the State Pomological Society. There is no appropriation for institutes, the expense of conducting them being met by the different organizations. The State board of agriculture during the past year held 12 institutes, attended by about 4,000 people, and a three-day annual meeting. A staff of 20 members, mainly from the Storrs and New Haven experiment stations, conduct these institutes, reports of which are published in the annual report of the State board of agriculture. The other two organizations held from three to five meetings each.

DELAWARE.

Farmers' institutes in Delaware are organized by counties, each of which is given a State appropriation of $200 a year.

Kent County.—Wesley Webb, Superintendent, *Dover.* In this county during the past year there were held 5 one-day institutes and 2 two-day institutes, with a total attendance of 2,300.

Sussex County.—S. H. Messick, Secretary, *Bridgeville.* During the year 2 one-day institutes and 2 two-day institutes were held, with a total attendance of 600.

Newcastle County.—A. T. Neale, Superintendent, *Newark.* During the year this county held 4 two-day institutes with a total attendance of 155.

FLORIDA.

C. M. Conner, Superintendent, *Lake City.*

Farmers' institutes in Florida are held under the auspices of the department of agriculture of the Florida Agricultural College and are distributed largely according to the wishes of the different localities. The institute staff is made up very largely of practical men throughout the State, and the arrangement of details is left entirely to the localities in which institutes are held. There is a State appropriation of $2,500 per annum, and railroads cooperate to the extent of furnishing transportation for institute workers. During the past year 22 institutes were held, with a total attendance of 3,300.

GEORGIA.

Farmers' institutes are not organized in Georgia.

HAWAII.

Jared G. Smith, President, *Honolulu.*

During the past year an association known as The Farmers' Institute of Hawaii was organized with the special agent in charge of the Hawaii Agricultural Experiment Station as president, and 4 successful meetings were held.

IDAHO.

H. T. French, Superintendent, *Moscow.*

In Idaho farmers' institutes are held under the management of the board of regents of the University of Idaho, who have designated the professor of agriculture in the College of Agriculture as superintendent. The institute staff is composed mainly of college and station men, six of whom participate in the work. The last legislature appropriated $1,000 for two years for institute work. During the past year 50 institutes were held, with a total attendance of about 17,000.

ILLINOIS.

A. B. Hostetter, Secretary and Superintendent, *Springfield.*

In Illinois there is a corporation organized under State law known as the Illinois Farmers' Institute, the officers of which consist of president, vice-president, secretary and superintendent, treasurer, and a board of directors, comprising the superintendent of public instruction, the dean of the College of Agriculture, and the presidents of the State Board of Agriculture, the State Horticultural Society, and the State Dairymen's Association, as ex-officio members, and one elective member from each Congressional district. There are also local institute societies, under whose immediate auspices the local institutes are held. There is no regular institute staff, but instead of this a list of 100 or more recommended speakers is furnished for the use of local organizations in making up their programmes. The total appropriation for the past year was $18,150, which included $2,500 for traveling libraries and $75 for each county taking advantage of the provision for holding farmers' institutes. One hundred and nine institutes were held, besides a four-day round-up by the State Farmers' Institute. The total attendance was about 39,000. Proceedings of the various meetings are published in a volume of about 500 pages, 20,000 copies of which are distributed.

INDIANA.

W. C. Latta, Superintendent, *Lafayette.*

In Indiana farmers' institutes are held under the auspices of the School of Agriculture of Purdue University, the professor of agriculture acting as superintendent. There is a small institute staff, including seven or eight members of the college and station staff, but the speakers are largely farmers, stockmen, fruit growers, etc., who have made a success in their particular lines. From his list of speakers the superintendent assigns two for each institute, the localities providing the remainder of the programme. A State appropriation of $10,000 is available for institute work. During the past year 201 institutes were held, with a total attendance of about 40,000. Proceedings of the institutes are published in the annual report of the State board of agriculture.

IOWA.

There is no central organization of farmers' institutes in Iowa. A State law allows $75 a year to each county holding an institute of forty or more practical farmers. Under this provision during the past year 65 institutes were held, with a total attendance of about 6,500. The State department of agriculture publishes such of the papers as are of general interest. A State farmers' institute under

the auspices of this department was held recently at Des Moines, and was attended by several officers of the Iowa State College of Agriculture and the Mechanic Arts.

KANSAS.

D. H. OTIS, Animal Husbandman Kansas State Agricultural College and Experiment Station, *Manhattan.*

Farmers' institutes in Kansas are held under the auspices of the Kansas State Agricultural College and are in charge of the professor of animal husbandry of the college. The staff is made up very largely of college and station men, 20 of whom devoted an average of 15 days each to institute work during the past year. With a State appropriation of $2,000, 102 institutes were held, with a total attendance of about 32,000. The only way in which proceedings are published is through the newspapers.

KENTUCKY.

I. B. NALL, Commissioner of Agriculture, *Frankfort.*

Farmers' institutes in Kentucky are held under the auspices of the bureau of agriculture, the commissioner of which is given entire control of the institutes and of the State appropriation for the bureau of $13,000 per annum, any part of which he may devote to institute work. The commissioner holds institutes only where there are local organizations to take charge of details and furnish halls and other accommodations for the meetings. During the past year 8 two-day meetings were held, with a total attendance of 1,600. Reports of these institutes are secured by an official stenographer, printed by the public printer, and sent out in editions of 10,000 to 12,000 to leading agricultural papers in the State, county newspapers, and postmasters. The agricultural and other papers send out these reports as supplements to their regular editions. The postmasters distribute the reports to the patrons of their offices. In this way it is claimed that the reports reach about 100,000 readers.

LOUISIANA.

J. G. LEE, Commissioner of Agriculture, *Baton Rouge.*

Farmer's institutes in Louisiana are conducted under the direction of the commissioner of agriculture, who is assisted greatly by officers of the agricultural college and experiment stations of the State. An appropriation of $2,000 for this work is made by the State. During the past year 38 institutes were held, with a total attendance of about 7,500. Proceedings are published in the annual report of the State board of agriculture and immigration.

MAINE.

A. W. Gilman, Commissioner of Agriculture, *Augusta.*

Farmers' institutes in Maine are held under the auspices of the State board of agriculture. Members of the college and station staff make up a part of the institute staff, but receive no pay for their work. A State appropriation of $3,500 is made, with which 37 institutes, with a total attendance of about 5,900, were held during the past year. Reports are published in the annual report of the State board of agriculture.

MARYLAND.

W. L. Amoss, Director, *Benson.*

The law in Maryland establishes a department of farmers' institutes in connection with the Maryland Agricultural College, and provides that the director of farmers' institutes shall be appointed by the trustees of the college. One institute is to be held annually in each of the 23 counties, and an additional institute in each county if deemed necessary. The staff is made up partly of college and station men, partly of successful farmers from different parts of Maryland and from other States. The State appropriation for this work is $4,000. During the past year 36 institutes, with a total attendance of about 1,500, were held.

MASSACHUSETTS.

J. L. Ellsworth, Secretary State Board of Agriculture, *Boston.*

Farmers' institutes in Massachusetts are held under the auspices of the State board of agriculture, a committee of which, together with the secretary of the board, has immediate charge of the work, subject, however, to certain restrictions, which recognize the incorporated agricultural societies of the State. The secretary each year prints a list of available speakers and their subjects, from which the agricultural societies choose speakers for the institutes. The funds for carrying on this work are drawn from an appropriation of $2,800, placed in the hands of the board for the dissemination of useful information, including lectures, crop reports, and farmers' institutes. During the calendar year 1901, 128 institutes were held, with a total attendance of 2,176. The State board of agriculture also holds two meetings a year—a summer or field meeting and a winter meeting. Proceedings are published in the annual report of the State board of agriculture.

MICHIGAN.

L. R. Taft, Superintendent, *Agricultural College.*

In Michigan farmers' institutes are held under the auspices of the State board of agriculture, which is in charge also of the State Agricul-

tural College and Experiment Station. Institutes are held by counties mostly and are under the local direction of county institute societies. The officers of these societies are furnished lists of speakers and subjects by the superintendent of institutes, and from these lists make up their programmes, which also include a number of local speakers. The funds for the support of farmers' institutes are appropriated by the State board of agriculture from a State appropriation of $100,000 placed in its hands for the support of the State Agricultural College, Agricultural Experiment Station, and farmers' institutes. For the past fiscal year the amount thus appropriated by the board was $7,500, which was devoted to the payment of traveling and other expenses of workers, administrative expenses, printing, and the expenses for a round-up meeting of institute workers at the agricultural college at the close of the season. During the year 255 institutes were held, with a total attendance of about 101,000. About 72 per cent of these institutes were one-day meetings. Proceedings of farmers' institutes are printed in an annual report embodying about 100 pages.

MINNESOTA.

O. C. Gregg, Superintendent, *Lynd.*

The Minnesota farmers' institutes are held under the auspices of an administrative board consisting of three members of the board of regents of the University of Minnesota and the presidents of the State Agricultural Society, State Horticultural Society, and State Dairymen's Association. A State superintendent of farmers' institutes is responsible to this board for the conduct of the institutes and the expenditure of funds. The institute staff is made up quite largely of practical farmers, stockmen, and dairymen. A State appropriation of $16,500 is available for institutes, of which 69 were held during the past year, with a total attendance of about 27,000. An annual report of about 400 pages is distributed annually to about 26,000 farmers. It is given free of charge only to those in attendance at the morning session of the first day of the institute.

MISSISSIPPI.

W. L. Hutchinson, Director Agricultural Experiment Station, *Agricultural College.*

Farmers' institutes in Mississippi are held under the management of the director of the Mississippi Agricultural Experiment Station, with a staff made up largely from officers of the agricultural college and experiment station. The last legislature appropriated $3,000 for institutes for two years. During the past year 40 institutes were held, with a total attendance of about 8,000.

MISSOURI.

GEORGE B. ELLIS, Secretary State Board of Agriculture, *Columbia.*

Farmers' institutes in Missouri are held under the auspices of the State board of agriculture, which has no official connection with the College of Agriculture and Mechanic Arts or the Experiment Station. These institutions, however, and the three normal schools, and the Missouri State Fruit Experiment Station cooperate with the board in this work and furnish a large percentage of the regular institute staff, which numbers about 20 members. There are also a number of local organizations which hold monthly meetings. Four thousand dollars of the fund appropriated for the use of the State board of agriculture is devoted to institute work. During the past fiscal year 104 meetings were held, with a total attendance of about 10,000. A novel feature recently introduced into the Missouri institute system is the railroad institute. Through the cooperation of railroads cars are fitted up for exhibition purposes and hauled from place to place without cost to the State board of agriculture. In fruit sections the car is furnished with spray pumps, collections of insects injurious to fruit, and the like; in dairy sections, with dairy apparatus; in live-stock sections, with typical specimens of live stock. Officers of the board, the agricultural college, and the experiment stations accompany the car and at each stop give demonstrations and hold institutes.

MONTANA.

S. FORTIER, Secretary, *Bozeman.*

Farmers' institutes in Montana are organized by law under a board of administration designated Directors of the Montana Farmers' Institutes, and consisting of the governor of the State and the director of the Montana Experiment Station, ex officio, and the presidents of the the following organizations: Montana Live Stock Association, Montana Horticultural Society, Montana Agricultural Association, Montana Dairymen's Association. The law provides that institutes shall be held at least once in each county each year, and appropriates $2,000 per annum for their support, including the printing of an institute annual. All members of the station staff participate in the institutes, and are assisted by volunteers from different parts of the State. During the past year 12 one-day and 5 two-day meetings were held, with a total attendance of about 12,000. Proceedings are published in an edition of 5,000 and distributed at institutes and by mail.

NEBRASKA.

E. A. BURNETT, Superintendent, *Lincoln.*

In Nebraska farmers' institutes are conducted under the auspices of the University of Nebraska and under the superintendency of the

director of the experiment station. The institute staff comprises 14 regular members and 13 others who are called upon occasionally. The State appropriation for institutes is $4,000. During the past year there were held 39 one-day institutes and 47 two-day institutes, a total of 86. The attendance was nearly 26,000. No proceedings are published.

NEVADA.

The first farmers' institute in Nevada was held this last year at Elko by the staff of the Nevada Agricultural Experiment Station. It was well attended.

NEW HAMPSHIRE.

N. J. Bachelder, Secretary State Board of Agriculture, *Concord.*

Under the auspices of the State board of agriculture about 40 institutes were held during the past year in New Hampshire, with an attendance of about 4,000. The expense of conducting these institutes was paid from the general appropriation for the board. Proceedings are published and about 2,000 copies are distributed.

NEW JERSEY.

Franklin Dye, Secretary State Board of Agriculture, *Trenton.*

Farmers' institutes in New Jersey are held under the auspices of the State board of agriculture and are under the immediate control of the secretary of that board. Speakers are chosen from a temporary list of about 30 workers. The annual State appropriation is $600. During the past year 12 one-day institutes and 5 two-day institutes were held, with a total attendance of about 5,000. Newspapers have been used freely heretofore in disseminating information regarding the institutes, but beginning with 1903 the proceedings of the institutes will be published in the annual report of the State board of agriculture.

NEW MEXICO.

Farmers' institutes are not yet organized in New Mexico.

NEW YORK.

F. E. Dawley, Director, *Fayetteville.*

In New York farmers' institutes are under the auspices of the commissioner of agriculture, Albany, who appoints a director of institutes. The permanent institute staff includes about 80 speakers, the temporary staff 20. From this staff the director delegates to each institute a conductor and one or more other speakers. The institutes are apportioned according to the agricultural interests of the various counties, and speakers are occasionally sent to assist at the meetings of the State associations of dairymen, bee keepers, breeders, fruit growers, and the Western New York Horticultural Society. The

annual State appropriation for institutes is $20,000, which is supplemented by local provision for rent of halls, advertising, etc. During the calendar year 1902, 269 institutes were held, with a total attendance of upward of 95,000. Proceedings are published in editions of 25,000 and distributed at institutes and from the department of agriculture.

NORTH CAROLINA.

S. L. PATTERSON, Commissioner of Agriculture, *Raleigh.*

Farmers' institutes in North Carolina are under the auspices of the State department of agriculture, which furnishes the necessary funds from its income from the inspection of fertilizers, the amount expended during the past year being $322.63. Halls in which institutes are held are provided by the different localities. The institute staff is made up almost entirely from the officers of the North Carolina College of Agriculture and Mechanic Arts and the Agricultural Experiment Station. During the past year 17 institutes were held, with a total attendance of about 1,700. Occasional bulletins on farmers' institutes are published in editions of about 20,000 copies.

NORTH DAKOTA.

E. E. KAUFMAN, Secretary, *Fargo.*

Farmers' institutes in North Dakota are held under the direction of the professor of dairying in the North Dakota Agricultural College, who is secretary of the institutes. The college and station staff participate largely in the institute work, but are not necessarily members of the regular institute corps. The State appropriation for this work is $1,500. During the past year 27 institutes, with a total attendance of 9,967, were held.

OHIO.

W. W. MILLER, Secretary State Board of Agriculture, *Columbus.*

Farmers' institutes in Ohio are placed by law under the control of the State board of agriculture, but local management is encouraged as far as possible. The officers of the institutes are chosen by local institute societies organized according to law and under the rules of the State board of agriculture. They conduct the meeting, but for each meeting 2 speakers are provided and dates and places for holding the meetings fixed by the secretary of the State board of agriculture. The institutes are supported by a per capita tax of 6 mills, which may not exceed $250 in any one county. Half of this tax is available for local institute expenses and half goes directly to the State board of agriculture for the payment of its various expenses. The total receipts from this tax during the past year were $16,784.13. During the past year 252 regular institutes and 26 independent institutes were held.

The total attendance was nearly 95,000. An annual State institute is held under the auspices of the State board of agriculture. The proceedings of the institutes are published in an edition of 10,000 copies, which are distributed by mail through the various agricultural societies and farmers' institutes.

OKLAHOMA.

J. B. THOBURN, Secretary Board of Agriculture, *Guthrie.*

The farmers' institute movement in Oklahoma is in process of organization. A State law provides that whenever nine counties shall have regularly chartered farmers' institutes, the governor may issue a call for the organization of a Territorial board of agriculture to have general control of the institutes. During the past year the director of the Oklahoma Agricultural Experiment Station has been actively engaged in organizing county farmers' institutes, and the requisite number having been organized, a call for a meeting of delegates was recently made by the governor and on December 18 the Territorial board of agriculture was organized by delegates from 13 counties. This board consists of six members elected by the delegates, and the governor, ex officio. The board elects a secretary who is not a member of the board and who is required, among other things, to arrange for an annual meeting of each institute at each county seat in counties having chartered institutes. He is required by law to cooperate with the agricultural college and station in the preparation of programmes. The county institutes already organized have been holding a number of meetings, some coming together as often as once a month. In other cases the counties are divided into four or more districts with local organizations auxiliary to the county organization. During the year 1902 officers of the experiment station attended 11 institutes, at 8 of which the attendance averaged about 50, and at the other 3 about 250.

OREGON.

JAMES WITHYCOMBE, Director Oregon Experiment Station, *Corvallis.*

Farmers' institutes in Oregon are held under the auspices of the Oregon State Agricultural College and are supported by college funds. The railroads of the State cooperate in this work to the extent of furnishing transportation for members of the college and station staff when engaged in institute work. During the past year 19 institutes were held, with a total attendance of 3,335.

PENNSYLVANIA.

A. L. MARTIN, Deputy Secretary of Agriculture and Director of Institutes, *Harrisburg.*

In Pennsylvania farmers' institutes are held under the direction of the deputy secretary of agriculture, who, by law, is made director of

institutes. There are also county organizations, and a local chairman of institutes, elected by the agricultural society of the town, if there be one, is in immediate charge of the institutes. The State appropriation is $15,000, from which $12.50 for a one-day meeting and $25 for a two-day meeting is placed in the hands of the local chairman to defray expenses of advertising, procuring hall, etc. There is a staff of about 50 regular workers and 14 supplies, from which the director of institutes sends at least 3 lecturers to each meeting. A number of regular lecturers are drawn from the officers of the Pennsylvania State College and Agricultural Experiment Station. Use is also made of 1,000 or more local speakers. During the past year 54 one-day and 135 two-day meetings were held, with a total attendance of over 144,000. A three-day round-up meeting of institute managers and lecturers is held annually. Farmers' institute bulletins are published and the proceedings, including the best papers presented at the institutes, are published in the annual report of the department of agriculture, of which 31,600 copies are distributed.

RHODE ISLAND.

G. A. Stockwell, Secretary State Board of Agriculture, *Providence.*

In Rhode Island occasional farmers' institutes are held under the auspices of the State board of agriculture, the expenses being met from a State appropriation of $15,000 for the use of the board. During the past year one institute with an attendance of 30 was held. Proceedings are published in the annual report of the State board of agriculture, 2,500 copies of which are distributed.

SOUTH CAROLINA.

J. S. Newman, Agriculturist Clemson Agricultural College and Agricultural Experiment Station, *Clemson College.*

In South Carolina farmers' institutes are conducted by the agricultural department of Clemson Agricultural College and the Agricultural Experiment Station connected with it, by a staff of nine members made up largely from officers of this department. There is no special appropriation for this work, the enterprise being supported by college and station funds. The expenditures for institutes during the past year were $571.43 from college funds and $480.18 from station funds, making a total of $1,051.61. Thirteen one-day meetings, with a total attendance of about 5,600, and a five-day round-up at Clemson College, with an attendance of 450, were held. No proceedings are published.

Thos. E. Miller, President The Colored Normal, Industrial, Agricultural, and Mechanical College, *Orangeburg.*

Institutes for colored people in South Carolina are being organized under the auspices of The Colored Normal, Industrial, Agricultural,

and Mechanical College. During the past year 17 institutes were held, with a total attendance of about 4,000. It is the intention to organize an institute in each county in the State and 35 of these are now in working order.

SOUTH DAKOTA.

There is no regular organization for holding farmers' institutes in South Dakota, and during the past year no such meetings were held.

TENNESSEE.

T. H. Paine, Commissioner of Agriculture, *Nashville.*

Farmers' institutes in Tennessee are organized under the department of agriculture, with the commissioner of agriculture in charge. There is a State organization composed of a few representative farmers from each county which meets annually; three division institutes, comprising delegates to the number of 500 to 1,000, which hold meetings that remain in session usually three days, and county institutes in many of the counties organized with a president, vice-president, and secretary, and holding one-day meetings. A State appropriation of $25,000 to the State department of agriculture is available for this work. During the last biennial period $4,032.58 was devoted to institute work.

TEXAS.

J. H. Connell, President, *Dallas.*

The Texas Farmers' Institute is a State organization which has held several annual meetings, but has no official connection with any of the State departments or institutions. Its officers are now engaged in organizing permanent county institutes, which will hold regular meetings under the auspices of the State organization. For the fall campaign of 1902, 13 two-day institutes were provided.

UTAH.

W. J. Kerr, President Agricultural College of Utah, *Logan.*

A State law in Utah places farmers' institutes under the auspices of the Agricultural College of Utah and provides that at least one institute shall be held annually in each county. The institute staff includes about 15 members and is made up largely of college and station officers. The State appropriates $1,500 annually for this work. During the past year 44 one-day institutes were held, with an attendance ranging from 29 to 300. Annual reports are published as college bulletins and are distributed in editions of 5,000 by mail.

VERMONT.

C. J. Bell, Secretary State Board of Agriculture, *East Hardwick.*

Vermont farmers' institutes are held under the auspices of the State board of agriculture, which is given some assistance by the officers of the State Agricultural College and Agricultural Experiment Station. The institute staff numbers about 15 members. The State appropriation for this work is $4,000, which covers all expenses. During the past year there were held 35 one-day meetings and 15 two-day meetings, a total of 50, with an attendance of about 10,000. Proceedings are published in editions of about 3,000.

VIRGINIA.

G. W. Koiner, Commissioner of Agriculture, *Richmond.*

Farmers' institutes in Virginia are held at the discretion of the commissioner of agriculture, who pays the expense of conducting them from State board of agriculture funds. During the past year 47 such meetings were held, with a total attendance of 14,100. The Virginia Polytechnic Institute has also held a few institutes on its own account. During the past year 6 of these were held, mainly along the line of the Norfolk and Western Railroad.

WASHINGTON.

E. A. Bryan, President Washington Agricultural College and School of Science, *Pullman.*

Farmers' institutes in Washington are held under the auspices of the Agricultural College and School of Science and the Agricultural Experiment Station, the officers of which make up the institute staff. They are held where applications are made for them and as frequently as members of the staff can be detailed to attend them. No definite sum is provided for the work. During the past year 31 institutes were held, with a total attendance of about 1,500.

WEST VIRGINIA.

J. B. Garvin, Superintendent, *Charleston.*

All farmers' institutes in West Virginia are held under the auspices of the State board of agriculture, aided by county institute societies, of which there are one or more in each county. Two members of the board attend each institute and have full charge of the employment of outside help. The secretary of the board is superintendent of institutes. The officers of the county institutes correspond with the superintendent, select places in the county for holding institutes, choose the speakers from a list sent out by the superintendent, and arrange the

programmes, which are printed by the public printer. The State appropriates for the total expenses of the board of agriculture $10,000 a year, of which about $5,000 is available for institutes. During the past year 75 institutes were held, with a total attendance of about 15,000. Such papers as are of general interest are published in the Farm Review, a paper of 32 pages, published by the State board of agriculture and having a circulation of about 6,000 copies.

WISCONSIN.

George McKerrow, Superintendent, *Madison.*

The department of farmers' institutes of the University of Wisconsin is given full charge of institutes in that State. A staff of about 30 workers, some of whom are officers of the university and the experiment station, is maintained. A State appropriation of $12,000 is devoted to the direction of institutes, the employment of workers, and to the payment of traveling expenses, etc. The rent of halls and the expense of printing programmes and advertising the meetings are met by the localities in which institutes are held. During the past year 10 one-day and 112 two-day meetings were held, with a total attendance of about 48,800. About 60,000 copies of the proceedings are distributed at institutes, by mail through clubs, etc.

WYOMING.

Farmers' institutes are not organized in Wyoming.

STATISTICS.

The figures in the following statistical table are derived from three sources: (1) Reports made by the presidents of the agricultural colleges in the several States and Territories to the Bureau of Education; (2) letters of inquiry sent to managers of institutes by the Division of Publications of this Department, and (3) letters of inquiry sent to managers of institutes by this Office. Repeated efforts were made to secure complete and reliable information regarding the funds devoted to institute work, the number of institutes held, and the approximate attendance, but in the case of some Commonwealths, where the farmers' institutes are not thoroughly organized, this was not possible. In such localities it was very difficult to secure complete data regarding the funds devoted to institute work, it being necessary in some cases to indicate the source of these funds without giving the definite amounts. There has thus far been no uniform system for recording the number of institutes and the attendance in the several States. Some institute managers have reported the number of institutes held during the fiscal year ended June 30, 1902; others the number held in the calendar year 1902. Some have estimated the attendance, others

have counted those present, while a few have employed a system of registry; some have attempted to get at the number of different persons in attendance at the various sessions, while others, probably the majority, have taken the sum of those in attendance at each session as the total attendance for an institute. The statistics given in this report are therefore only approximate, but will serve to indicate the relative extent of the institute movement in the different States. It is hoped that hereafter a system may be devised under which more exact statistics of the farmers' institutes throughout the country will be obtained.

Statistics of the farmers' institutes.

State.	Funds for institutes.		Number of institutes held.	Approximate attendance.
	State.	College and other funds.		
Alabama		$600.00	24	2,616
Arizona			2	350
California		4,000.00	63	20,000
Colorado		(a)	15	
Connecticut			12	5,000
Delaware	$600.00		15	3,055
Florida	2,500.00		22	3,300
Hawaii			4	180
Idaho	500.00		50	17,000
Illinois	18,150.00		110	39,187
Indiana	10,000.00		201	40,000
Iowa	(b)		65	6,500
Kansas	2,000.00		102	32,450
Kentucky		(a)	8	1,600
Louisiana	2,000.00		38	7,500
Maine	3,500.00		37	5,920
Maryland	4,000.00		36	1,500
Massachusetts		(a)	128	2,176
Michigan		7,500.00	255	101,000
Minnesota	16,500.00		69	27,205
Mississippi	1,500.00		40	8,000
Missouri		a 4,000.00	104	10,000
Montana	2,000.00		17	1,200
Nebraska	4,000.00		86	25,800
Nevada			1	
New Hampshire		(a)	40	4,000
New Jersey	$600.00		17	5,000
New York	20,000.00		269	94,688
North Carolina		$322.63	17	1,700
North Dakota	1,500.00		27	9,967
Ohio	16,784.13		278	94,655
Oklahoma			11	1,150
Oregon		(c)	19	3,335
Pennsylvania	15,000.00		189	144,431
Rhode Island		(a)	1	30
South Carolina		1,051.61	{ 14 17	6,100 4,000
Tennessee	d 2,016.29			
Utah	1,500.00		44	
Vermont	4,000.00		50	10,000
Virginia		(a)	47	14,100
Washington		(c)	31	1,500
West Virginia	5,000.00		75	15,000
Wisconsin	12,000.00		122	48,800
Total	145,650.42	17,474.24	2,772	819,995

a Expense of conducting institutes met by funds appropriated for State boards or departments of agriculture.
b $75 for each county holding an institute.
c Expense of conducting institutes paid from college funds.
d Half of the $4,032.58 devoted to farmers' institutes during the last biennial period.

"POPULAR" EDITIONS OF STATION BULLETINS.

By F. H. Hall,

Editor and Librarian, New York Agricultural Experiment Station.

In the act of Congress giving national support to the experiment station movement the acquirement and diffusion of information is the first-mentioned of two coordinate lines of station activity. The idea in the word "acquiring" of the act is to some extent modified, or explained in the clause stating the second object of the establishment of stations—"to promote scientific investigation and experiment"—and in section 2, which specifies some of the lines along which research efforts may be directed; but beyond providing that annual reports and quarterly bulletins of progress shall be issued, Congress has placed no limitations upon methods of "diffusing" the information secured. Certain specifications are, indeed, laid down as to subject-matter for the annual reports, but the stations are left without restriction as to form, size, subject-matter, and manner of treatment of bulletins.

This omission to order, to recommend, or to forbid any particular form or style of announcing results is in accord with the general tenor of the Hatch Act along other lines; for it was the intention of Congress to give the greatest liberty in matters of detail to the States and to the stations they might establish. It was not, assuredly, the purpose, in passing thus lightly over this phase of station work, to minimize its importance.

The principal means of communication between a station and its constituents must be the printed page, though there are other subordinate channels which serve valuable purposes. Personal interviews with members of the staff at the station or elsewhere must be comparatively rare, and station correspondence can reach only scattered individuals, though the information imparted through these channels can be given a pertinency and a fitness for the personal needs of the seekers after knowledge which it does not have when embodied in a pamphlet written to cover conditions of more or less general prevalence. The extension of these two methods of communication by answering letters through the columns of newspapers, by contributing to the press more formal articles relating to station work, and by addressing considerable numbers of farmers at institutes and similar

gatherings increases the number of those benefited. But these methods are not capable of indefinite expansion and are subject to many objections as primary agencies for distributing information relating to experimental investigation. There are undoubtedly stations, especially in States where scientific agriculture is in its infancy, which depend upon these informal methods of communicating with their constituents more than upon bulletins and reports; but it is to be questioned whether such stations are not doing work which belongs more properly to the agricultural college, to the neglect of their own peculiar field—investigation. Extensive correspondence with individuals or through the newspapers and frequent trips over the area of country to impart instruction prove very great detriments to careful, consecutive scientific experimentation, and the executives of many stations, who feel that the supreme usefulness of such institutions lies in their investigations, do not make special effort to encourage, though they do not discourage, correspondence and trips to meet and aid the individual farmer.

For these stations, and to a great extent for all stations, the chief dependence in reaching the farmers, fruit growers, feeders, and breeders who look to them for advice and guidance must be some form of printed matter distributed through the mails; in other words, the reports and bulletins mentioned in the Hatch Act. Since these publications now announce net results from the annual expenditure of one and one-fourth million dollars and should ultimately convey "useful and practical information" to more than five and one-half million farmers, they deserve most careful study in order to secure the greatest effectiveness at the least outlay.

There are now, and probably always will be, two quite divergent views regarding the purpose of station effort and the best aim for station publications, and the methods of disseminating information most useful to stations of one class will not be equally applicable to those of another class. That is, the stations which seek, first, to uplift directly the practice of the many badly trained or routine farmers will not work along the same lines nor adapt their publications to the same type of readers as do the stations which direct most of their efforts to the solution of problems involving deep research for basic principles. For stations in either of these two general classes a perfectly uniform system of publications could not be secured, even if it were desirable, since legislative enactments and other local restrictions upon station executives differ greatly in the different States, but it seems unnecessary that each station should vary from almost every other, as is the case now, in the character of the matter found in the annual report or its bulletins, in the general style of presentation of experimental work, and in the classes of publications issued. There undoubtedly can be, and probably will be, developed some general system which, varied in minor details to suit particular conditions, will be found more

effective and more economical than any other for the many stations which do work of similar character and grade and appeal to constituencies very much alike in mental ability and equally advanced in agricultural practice.

A brief glance at the publications of the American stations will show what diversity of treatment exists. The earlier stations in this country looked to the stations of Germany for methods of dissemination of results, as well as for methods of work, and for a short time patterned after them in this respect as far as very different conditions would allow. Foreign stations, particularly those of Germany, make use, to a great extent, of periodicals in announcing their labors. The Landwirtschaftliche Zeitschrifte of the German, Austrian, and Swiss provinces, the Deutsche Landwirtschaftliche Presse, and similar papers serve to promulgate popular information, while the Versuchs-Stationen, Landwirtschaftliche Jahrbücher, Journal für Landwirtschaft, and various Centralblätter and Zeitungen record the scientific side of station work and are really official organs of single stations or groups of stations; and the various French journals and bulletins serve a similar purpose. The American system has never provided for such official organs; but some of the pre-Hatch Act stations printed and sent to editors small editions of their bulletins which served as copy for such papers as cared to print them, and in a few cases selected one paper with which arrangements were made for regular publication. To this plan of newspaper announcement of station results there were, and are, many objections; and when the Congressional enactment extended the franking privilege, the printing of bulletins by the press as a permanent feature ceased. Many stations, however, still avail themselves of newspapers as an additional agency in making known or enforcing points of practical importance brought out by experience or planned experiment. "Press bulletins," "Timely topics," "Hints for farmers," etc., appear to be increasing in number and popularity and indicate a trend in the direction of wider dissemination of the station experience in simple form, a movement in line with the modification of the bulletins to be discussed later.

The Hatch Act requires two classes of publications; and many of the stations confine themselves to the minimum of kinds and also to the minimum of numbers; others issue from three to six classes of publications—bulletins, special bulletins, press bulletins, meteorological bulletins, technical bulletins, circulars, spray calendars, newspaper notices—and publish from five to twenty bulletins a year.

The annual report may be merely a leaflet or small pamphlet giving a summary of financial transactions and the briefest account of station progress during the year. It may, on the other hand, be a 500-page volume containing the bulletins issued during the year, extended discussion of work along practical or scientific lines which have not been published in bulletin form, a statement showing the receipts and

expenditures down to the smallest item, a general survey of station progress and policy by the director, and full reports from each department or upon each line pursued. These are perhaps the extremes, while every gradation between the two types is or has been used by some of our stations.

The bulletins differ in as marked a manner. There has been a concerted attempt, continued for several years, to secure uniformity in height and width so that the collected station literature might be bound in similar volumes; and reasonable success has attended these efforts, but along other lines diversity appears to be the key word. A bulletin may be a monograph or a miscellany. It may deal exclusively with a planned experiment to ascertain a single fact; it may be merely an annotated list of the plants of some region, or it may be a manual of cattle feeding or fruit culture. The matter may be written for the advanced chemist and contain 10-syllabled words used without explanation, or for the "book-shy" feeder to whom "protein" and "carbohydrates" are as Greek. The pamphlet may be printed on the flimsiest of wood pulp or on supercalendered stock. It may be void of illustrations, crude and faulty in style, even glaringly ungrammatical; or it may show fine half-tone plates and correct and artistic drawings, and be a model of correct, clear, and forceful English. If written in popular style for the farmer, the scientist may have to content himself with inadequate data, or he may find in the annual report a full and accurate presentation of the same work. If scientifically full in its first treatment, the matter may be preceded by a summary in more simple terms, or it may be supplemented by an abridged or popular edition for the untrained or busy reader. A few stations attempt a separation of popular or practical information, and that of a scientific or technical character by issuing bulletins in series separately numbered; while others make no distinction in numbering, but distribute bulletins of special applicability to selected sections of their mailing lists. In other cases all bulletins are sent to each name upon the mailing list, leaving it to the recipient to neglect them, if they are technical and he a busy farmer, or if they are popular and the recipient an investigator intent upon causes and principles and satisfied only with full and logical data.

Possibly conditions justify all these diverse forms, which appear to have arisen through the efforts of each station, acting independently, to develop a system suited to its needs. The writer would not suggest for any station a radical change to secure uniformity; yet he believes that one feature of the system now in use at the New York Agricultural Experiment Station is well worth the consideration of station executives. By the introduction of this feature the publications of the station have been fitted to serve better both farmer and scientist, with a lessening of expense for printing. This change in the system of bulletins involves printing them in two editions, one written by the

experimenter, with a discussion of the work in detail, giving data with fullness and scientific accuracy; while in the other edition it is sought to meet the needs of the farmer and busy man by a short, simply worded outline of the experiments and a clear presentation of the practical bearing of the facts revealed by the work.

The idea of double publication of results in scientific (unabridged) bulletins and popular editions originated at the North Carolina Station, but to Dr. Jordan, the director of the Geneva Station, is to be given the credit for the successful development of the system. To the writer fell the duty of editorship of the publications, and he has in consequence taken a deep personal interest in the workings of the system and has sought in various ways to learn to what extent it is a success or failure. Almost without exception the comments which have reached us have been favorable, and the basal idea of the system has been already adopted by some stations and is soon to be used by others. The few adverse criticisms have been due to misconceptions of the plan and its purpose or to differences of opinion as to the style best suited to the popular edition.

The farmers of the State seem to prefer the "popular" edition, though free to choose either; and many of them have assured the station that these bulletins are much more generally read and followed in practice than was the case when one edition was issued. Of more than 36,000 persons in the State receiving bulletins from this station, less than 900 ($2\frac{1}{2}$ per cent) have requested that the complete bulletins be sent them regularly. Many papers also have spoken well of the system, and in numerous instances have aided to spread the information sent out by reprinting the popular bulletins in full. To the extent to which this is done the station is assured of correct and effective announcement of its work, while the ordinary newspaper abstract of station publications is often misleading, if not incorrect.

The system would probably not have been so applicable nor so well received earlier in the history of the station, nor is it now of as great value to stations doing "pioneer" work for the agriculture of their section. The earlier stations, certainly, and probably every station, to a considerable extent, found it necessary to teach many elementary truths of immediate utility which could be brought out by "practical" experiments and whose application to farm methods would work great benefit to agriculture. These dealt largely with details of practice, and while the experiments had to be carried out with more care than the farmer would use and included lines of inquiry he would not think of, they did not, in most cases, involve much with which the ordinary agriculturist was unfamiliar. The announcement of the results could be given in detail sufficient for the purposes of fellow investigators, yet not greatly weary the farmer, since the stations were working with agencies he knew well. It is probable, however, that even with experiments of this elementary character the farmer

of ten or twenty years ago would have preferred a shorter and more familiar account to the long treatises he sometimes received.

There were also some new principles relating to fertilizers and their application, feeding problems, insecticides and fungicides, bacteria in dairying, and allied topics, in which the tiller of the soil and the feeder must be instructed and which they must be led to use by repeated illustrative experiments. Bulletins dealing with work of this character were written for the farmer alone usually and not for the scientist, and it was necessary in them to write at length and with many different presentations of the same idea in order that the readers might get a clear and comprehensive view of the new truths presented. The proportion of such bulletins was much greater during the first ten years of general station activity than it need be now, when this foundation work has been well done by numerous stations, and when the principles of fertilizer application, feeding, dairying, and soil treatment are understood by a numerous body of institute workers, contributors to the agricultural press, and leading farmers in almost every community.

Practical experiments are still needed; many of them and careful ones carried through such long periods of time and with such close checking of conditions that the data accumulated will be of scientific value and will be worth study by experts, both to be certain that no errors of interpretation have led to false conclusions and as a basis for planning work along similar or slightly divergent lines. The farmer, however, is too busy a man in this hustling age to be willing, if able, to give attention to the details of long or complex experiments, even in fields familiar to him. Through ten or fifteen years of experience with station workers, with few instances of incapacity or lack of thoroughness and almost none of dishonesty, the discriminating farmer has learned to trust station conclusions and does not ask fullness of detail so that he may have a check upon the experimenter. In our experience, at least, he prefers the concise, simply worded outline of the experiments, with plainly stated practical conclusions and careful directions for applying to his own work the truths developed.

Station work in America tends now, as it has done for years abroad, toward deeper studies than have occupied the majority of workers in the past, and many investigations now call into play the keenest faculties of the physiological chemist, the bacteriologist, the plant physiologist and pathologist, the entomologist, the biologist, as well as the trained hand and eye and the fund of experience of practical handlers and judges of the processes and products of the farm and garden. These investigations lead into realms where the most intelligent farmer need not be ashamed to confess himself lost, yet the results are likely in the future, as they have in some cases in the past, to revolutionize some branch of agricultural practice. The details of such investigations, the preliminary discussions which prepare the ground for intel-

ligent understanding of the work, and the theories proven or overthrown by the results are of little interest to the practical agriculturist. He can not read understandingly such a discussion of work of this character as would satisfy the student, and he can not be blamed if he relegates the scientific bulletin to his file unread or even throws it into the waste basket with an expression of dissatisfaction at the station for sending it. Yet the brief story of the investigation put in homely, everyday words, with an indication of the possibilities of practical benefit from the work, he may read in ten minutes and find extremely interesting and profitable. If he chance to be a specialist along the line covered by the bulletin and desirous of studying the question further the full details are accessible in the regular edition, and this the expense of a postal card will secure by return mail. He need not wait until the freshness of his desire has lessened or the lapse of time made him forget, as in the case where scientific discussions are given only in the annual report of the station.

On the other hand, scientists and fellow-investigators, if interested at all in an experiment, are interested in the details and in the discussion of theories and principles. Data should be placed in the hands of these men as soon as practicable and with the fullness of detail which the experimenter considers desirable. The latter should not be hampered for space, as is often felt to be necessary when large editions of bulletins must be printed, in which the expense of a few additional pages counts up rapidly. Neither should the author be compelled to delay publication, both since credit for scientific work frequently depends on priority of announcement and since the facts discovered, if valuable as a guide in further investigation, are doubly valuable if soon made known. The long delay in appearance of annual reports which have to pass through the hands of State printers must certainly be exasperating to the man who has done a good piece of work and sees weeks and months pass while his discovery lies buried in manuscript. It may be said that such discoveries should be announced in scientific periodicals and credit thus secured. This might serve were the experimenters alone concerned; but unless great care is used, both by the author and by the journal in which he publishes, the station does not receive its proper share of the credit for the work. Most stations on this account demand that members of their experimental corps announce results first in station publications.

Thus, to secure effectiveness for two very diverse classes of interested readers and to insure the prompt appearance of both popular and scientific discussions of work performed, the complete and summarized editions have advantages over other forms of station publications. This double publication also gives a stimulus to station workers, who as a rule are scientific men, in the opportunity which it affords of presenting the result of their researches in a full and scientific manner;

and any stimulus to scientific enthusiasm is desirable. Such an opportunity is not supplied by the publication that is a compromise between a scientific and a popular presentation.

It is probably the first thought of those to whom the idea is new that such duplicate discussion of results means a great increase in expense. The contrary is true so far as printing is concerned, for the setting up of type for the popular edition is a very small item—the saving in paper, presswork, and handling, through the smaller size of the popular bulletins, a large one when 10,000 or more bulletins are printed. In the last report of the Office of Experiment Stations the bulletins issued by the stations during the fiscal year are listed. The total number of pages contained in those which, from their titles, appear suitable for publication in two editions is 7,400, and the average number of names on the mailing lists is nearly 12,000. To print 7,400 pages of matter in an edition of 12,000 at 50 cents a page for each 1,000 copies, which is a fair figure, would cost $44,000. If complete and popular editions were printed, it would probably be necessary to make the editions 2,000 and 11,000, respectively, providing 1,000 copies for duplication, and the popular edition, at the ratio which exists between the two editions at Geneva, would contain 2,100 pages. The 2,000 copies of the complete edition would cost at 55 cents a page per 1,000 copies (also a fair figure for editions of this size) $8,140, and the 12,000 copies of the popular edition at 50 cents a page per 1,000 would cost $19,690, which makes a total for the two editions of a little more than $27,800, a saving over the cost of the single bulletin of $17,000.

But it is not to the average station, and especially not to the station publishing the mininum number of the bulletins and sending them to a few addresses, that the system is particularly applicable, but rather to those publishing ten or more bulletins annually and having mailing lists of from 15,000 to 40,000 names. For the station publishing 10 bulletins of 30 pages each (which is about the average size) and having a mailing list of 20,000 names, the yearly saving in the cost of printing would be $1,830, as follows:

20,000 copies of 300 pages (10 bulletins of 30 pages each), at 50 cents a page per 1,000 copies		$3,000
2,400 copies of 300 pages, at 55 cents a page per 1,000 copies	$396	
18,000 copies of 86 pages (popular), at 50 cents a page per 1,000 copies	774	
Total		1,170
Difference		1,830

The figures just given are based upon the ratio derived from the comparison of the number of pages in the complete bulletins issued at Geneva and the popular editions of the same bulletins, but this ratio does not express one which might be established and which would decrease the expense for the popular bulletins about one-fifth, since each bulletin issued by this station, whether complete or popular,

devotes two pages to cover and list of officers. Many stations might consider these pages unnecessary, in large part at least, for popular bulletins.

Against the saving thus shown must be placed the cost of preparation and proof reading of the extra edition, but for stations publishing extensively, at least, the saving will provide the salary of an additional member of the staff, to combine editorial duties with some other functions. An editor, chosen with regard to his fitness for such work, can assist the other members of the staff materially in the preparation of manuscripts for the regular bulletins; he secures uniformity in station publications and insures accuracy, clearness, and force in the presentation of results; he relieves the experimenters of the unfamiliar and, to many, distasteful work of the proof reading and of the wearisome struggles with printers; he provides for correct and pleasing typography and satisfactory handling of the printed matter, and in many other ways may be of great value in keeping the publications of the station up to the mark or improving them. Such work frequently falls upon the director, but much of it is of a routine character and hardly worth the time and attention of so highly paid an officer.

The editor would also write the popular editions, familiarizing himself both with the experimental side of the work and with actual practice, so that his discussions may be both true to the fact and applicable to existing conditions.

Editorial duties will not occupy all the time of one man at any of our stations, but one who is capable of doing good editorial work should also be a valuable assistant in many other directions. Since the saving on the popular bulletins would nearly or quite pay the salary of a well-qualified man, his services in other directions would be so much gained to the station, either in direct productive effort or in economy of the time of men who desire to devote all their energies to investigation.

For stations publishing but few bulletins, of course, the employment of a special editor is not feasible; but the rewriting of the results of scientific or complex experiments into shorter, simpler form can be satisfactorily done by the author of each bulletin, by some member of the staff who shows special fitness for such work, or even by some writer for the press who is familiar with agricultural science and agricultural practice. It is probable that by any of these methods some financial advantage would be gained, and it seems certain to the writer that opportunity afforded for careful discussion in the complete bulletin would be appreciated by the experimenter and his scientific readers, and that the conciseness, simplicity, and readableness of the popularized bulletins would appeal with enough greater force to the farming constituency of the station to justify the rewriting if the cost were not wholly met by the lessened expense of printing.

COOPERATION BETWEEN EXPERIMENT STATIONS AND FARMERS.

Owing to the wide extent and growing importance of cooperation between experiment stations and their constituents, invitations were extended to the officers in charge of cooperative enterprises of this nature in Alabama, Illinois, New York, and the Province of Ontario to contribute articles on this subject for the annual report of this Office. These examples were chosen as typical of certain phases of the movement. Alabama exemplifies the movement as applied to Southern conditions; Illinois presents an example of a station making scientific investigations on lands rented and controlled by the station; in New York the station tests varieties of crops and methods of culture, and the farmer tries those crops and methods in his own fields; in Ontario the ends sought are much the same as in New York, but they are attained through an organization developed for this special purpose, the Ontario Agricultural and Experimental Union, which has a membership of nearly 300 graduates and ex-students of the Ontario Agricultural College living in all parts of the province. Experimental unions modeled after that in Ontario have been organized in Ohio and Wisconsin and are developing a similar system of cooperation. In many other States various modifications of the cooperative enterprises here described at length have been in operation a number of years or are now being developed.

In the articles here presented the endeavor has been to bring out the following features regarding cooperative experiments in the sections under consideration: (1) Origin and brief history of the movement; (2) present status of the movement, including statements regarding the extent and character of different phases of it, the number of experimenters, how the cooperation of these experimenters is secured, to what extent they are directed and controlled by the central authority, what incentive is offered them to undertake and carry through the work, cost of the work and how met, and a detailed description of a typical experiment; and (3) value of cooperative experiments to the station or college, to the farmers, and to agricultural science.

Regarding the value of cooperative experiments, it has been found in general that they enable the station to direct and control the distribution of seeds and plants in such a way as to secure many reports of

real value regarding their adaptability to different soils and climatic conditions; to introduce improved methods of cultivation, feeding, and farming methods generally, and to gain a better knowledge of the real needs of the rural communities. They enable the farmer to secure new and improved varieties of seeds and plants; they train him along scientific lines, encourage him to read, help him to understand what he reads, and arouse in him an interest in the work of his station and college. For the promotion of agricultural science they exert a wholesome influence, not only among the cooperating farmers, but also among all who see the experiments; they furnish a check on station experiments and on the drawing of hasty conclusions, and they enable the stations to investigate local problems in a thoroughly scientific manner without acquiring in those localities costly land and other equipment which must be disposed of subsequently at a sacrifice. Finally, they become a most effectual agency for bringing the agricultural colleges and experiment stations into close and mutually helpful relations with the farming communities.

COOPERATIVE EXPERIMENTS CONDUCTED BY THE ALABAMA AGRICULTURAL EXPERIMENT STATION.

By J. F. DUGGAR, *Agriculturist.*

Any investigation in which an experiment station unites with an individual, with another experiment station, or with any other institution, may be called a cooperative experiment. Cooperative experiments in this country may be roughly divided into at least four classes, namely:

(1) Those investigations undertaken jointly by two or more experiment stations, as, for example, experiments on acclimation fever of cattle, conducted by the Texas and Missouri stations, and quite a number of tests of the effect of a change of seed from one latitude to another, in which a number of stations have participated.

(2) Investigations conducted jointly by the United States Department of Agriculture and one or more of the experiment stations.

(3) Experiments made by the National Department of Agriculture in cooperation with some individual.

(4) A partnership in experimentation between some individual and the experiment station of the State in which he lives.

It is only with this last form of cooperation that this paper deals. Its purpose is to set forth the experience of the Alabama College Station during a period of thirteen years, this being the time during which this station has conducted experiments in cooperation with farmers. It is hoped that a statement of the cost of this work, of some of its results, of its advantages, and of the difficulties that beset this form of experimentation, may prove useful to investigators in other institutions by suggesting methods of solving those problems that can not be worked out at the experiment station.

PURPOSE.

Few States afford such a number and variety of soils as Alabama. No adequate data exist for the classification and enumeration of the different classes of soils in this State. The principal data for a preliminary and tentative classification are to be found in the reports of the State geologist, Dr. Eugene A. Smith, and in the geological map which he has published. From this map and from personal observation in almost every county in the State the writer feels confident that the soil of Alabama consists of at least fifty different kinds, with the probability that this number is a low estimate. Hence the problem of local experimentation is quite a difficult and complicated one in this State, and any complete system intended to discover the fertilizer requirements of every type of soil in the State would require extensive expenditures and much more complete supervision, especially in the choice of sites for local field experiments, than this station has been able to afford. But the fact that the soil at Auburn is so far from being representative of the soil of the greater part of the State made it almost imperative that some effort, however partial or incomplete, should be made to ascertain the fertilizer requirements of at least the most extensive soil belts of the State.

Hence, cooperative experiments in Alabama have been chiefly fertilizer experiments. So generally has this been the case that these experiments in Alabama have usually been designated as "soil tests." In order to make this work as practical as possible, and the results as immediately applicable as possible, one principally and universally grown crop, cotton, has been the plant generally employed in these tests. There is an additional reason for the choice of cotton in preference to some other widely grown staple—for example, corn—in the fact that cotton responds more profitably to commercial fertilizers than does corn, and in the further fact that the great bulk of the commercial fertilizers used in Alabama is applied to the cotton plant.

HISTORY OF COOPERATIVE EXPERIMENTS IN ALABAMA.

The first cooperative work under the Hatch Act was begun in 1889, when nine lots of fertilizers were sent to as many farmers in various parts of the State. Of this number the results obtained in only three experiments were regarded as instructive or reliable, and these three reports were published in Alabama College Station Bulletin No. 12.

Apparently this small beginning had been made without any specific appropriation for this purpose. The first reference to soil tests in the financial records is the statement that expenditures on this account were made in 1890 from the Hatch fund to the extent of $268.89. This appropriation of about $300 enabled the extension of the work so as to include 30 experiments. Twenty-four reports were received

and published in Alabama College Station Bulletin No. 23. For the three years beginning in 1890 the average annual expenditure for soil tests was about $300. In 1893 this sum was increased to nearly $400. During that year one of the assistants in agriculture devoted a large part of his time to inspecting the different experiments. However, for reasons unknown to the writer, none of the results of that year were ever published.

During the last seven years the annual cost of the cooperative experiments, including a few tests that were not strictly fertilizer experiments, has averaged less than $200. The appropriations for this purpose have been drawn from both the Hatch fund and the fund derived from the analysis of fertilizers. The usual number of local fertilizer experiments conducted each year is from 25 to 40.

The total number of fertilizer experiments or soil tests made with all crops from 1889 to 1902, inclusive, slightly exceeds 400. Of this number of experiments begun, nearly 300 have been carried to a conclusion and the results reported. More than 200 of these are regarded as being somewhat conclusive in showing the fertilizer requirements of the local soil. Hence we may say that more than half of the cooperative experiments provided for have been valuable and effective.

The data relative to cooperative fertilizer experiments with cotton have been published in the following bulletins of the Alabama College Experiment Station: Nos. 12, 23, 34, 42, 78, 91, 102, and 113. The data for the past two years has yet to be published. In Alabama College Station Bulletin No. 107 (pp. 270–288) deductions are made as to the fertilizer requirements of certain soil belts, as indicated by the results obtained from 1897 to 1899, inclusive. Other data from cooperative experiments are summarized on pages 227–229, 232–237, 241, 242, and 247–251 of the same publication.

The fertilizer experiments of 1893 and 1895 were made with corn, and the results were never published. In Bulletin No. 111 may be found an account of cooperative fertilizer tests with corn conducted in 1889 and 1900. There is on hand awaiting publication the results of quite a number of such experiments with corn in 1901 and 1902.

Changes in plan of work.—It is true of nearly all experimental plat work that the best results flow from continual repetition on a uniform plan from year to year. The work in Alabama has suffered several changes in plan incident to changes in the station staff and to modifications which experience showed to be desirable. Practically no change has been made in the amount or kind of acid phosphate employed, which has been usually 240 pounds per acre. Potash was obtained in the form of muriate in most of the earlier tests and in the form of kainit in the tests made during the last seven years. The source of nitrogen in these tests last mentioned has been cotton-seed meal, but in the earlier years either nitrate of soda or sulphate of ammonia was used.

In general terms it may be said that there was practical uniformity in the plans under which were conducted the tests made in 1891, 1892, and 1893, and that the two years' experiments prior to these dates were in accordance with plans nearly similar to these. For each of the six years 1897 to 1902, inclusive, there has been absolute uniformity in plan.

Among questions investigated in the past and still pressing for final solution, but which are no longer under test in the cooperative work because of the greater importance of other problems or because they are being investigated on the station farm at Alabama, are the following:

(1) The best form of nitrogen for corn and cotton, using cotton seed, cotton-seed meal, stable manure, sulphate of ammonia, and nitrate of soda as sources of nitrogen.

(2) The best source of phosphoric acid, using acid phosphate, floats, and Florida soft phosphate.

(3) Effect of lime when applied to cotton.

Simple rotation experiments and tests to determine the effect of plowing in certain legumes as fertilizers were once begun, but experience indicates that investigations of this nature, which need to be extended without interruption over several years, are best conducted at a substation where some degree of permanence is assured.

In forming a permanent plan for cooperative fertilizer experiments there was considerable hesitation as to whether to use as a source of nitrogen cotton-seed meal, which is the form in which most farmers would employ nitrogen, or to substitute nitrate of soda. The latter has the very decided advantage of being free from all admixture of phosphoric acid or potash, and hence in giving results more clear-cut and easy to interpret correctly. Our decision was finally in favor of cotton-seed meal, so that the teachings of the experiments might be more readily adopted in localities already familiar with the use of that fertilizer. For example, it was thought that if our tests should demonstrate that cotton growing on a certain soil needed 14 pounds of nitrogen per acre, farmers would be more apt to follow the advice of the experiment station if the experiments leading to this conclusion were made by using 200 pounds of cotton-seed meal than if made with about 90 pounds of nitrate of soda per acre. Looking back now upon the thirteen years' results the chief regret must be, not that one or the other plan was adopted, but that one or the other plan was not followed with absolute uniformity during the entire period. Where work of this character is begun with any probability of permanency, much time should be given to the working out of a plan that can be followed implicitly for many years.

Duration of tests.—Our present plan is to induce each satisfactory experimenter, if possible, to continue the test during three years, so that the average result may give a more reliable indication of the

needs of his soil than would be afforded by a single test. In the greater number of cases, however, the experiment has continued only one or two years. This condition has arisen from a number of circumstances, the experimenter sometimes, in his opinion, obtaining sufficient information as to the needs of his soil from a test of one or two years, or tiring of the large amount of unremunerative labor, or other causes making a change of the location of the test desirable. Doubtless, if the experimenter received any cash compensation, a larger portion of our tests would be continued through the three-year period, which we desire as a basis for a satisfactory average. The uncertainty as to the duration of any test, however promising the first year's results may be, is one of the principal disadvantages of this method of experimentation.

PRESENT STATUS OF OUR COOPERATIVE EXPERIMENTAL WORK.

Lines of work.—By far the larger portion of our cooperative tests have for their object the gaining of information as to the fertilizing materials of which the different soils of Alabama stand most in need. The ultimate aim is to obtain sufficient data to serve as the basis for a map showing the fertilizing elements most imperatively needed by certain crops in the different parts of the State.

(1) Cotton continues to be used as the principal crop for measuring the fertilizer requirements of the various soils that are being studied. Incidentally much has been learned as to the effects of kainit as a partial preventive, under some conditions, of the destructive "black rust" of the cotton and of the effect of acid phosphate in hastening the maturity of the bolls.

(2) The fertilizer requirements of corn on different soils at present constitute a considerable proportion of our cooperative endeavors, chiefly for the reason indicated under the next head. However, there are problems in corn culture more important than its fertilizer requirements, and demanding a larger outlay for inspection of the local experiments than has been within the means set aside for our cooperative work.

(3) The relative fertilizer requirements of cotton and corn have been investigated by having the fertilizer experiments with cotton and with corn conducted on adjacent and similar soil. The averages of a number of such comparisons show most interesting differences in the manurial requirements of the two plants, cotton responding more profitably to phosphoric acid and potash, and corn generally yielding much better in the presence of nitrogen than either of the other two valuable elements. This series of experiments has been carried on for several years, both on the station farm at Auburn and at selected localities elsewhere.

(4) Fertilizer experiments with wheat have been begun. The most useful feature of the work thus far has been the revelation to the farmers making the test of the prompt and profitable effects of nitrate of soda when applied in March as a top-dressing for the small grains. The difficulty of having numerous small lots of wheat thrashed separately has been one of the principal difficulties in this line of work.

(5) Fertilizer experiments begun in 1901 on Johnson grass and Bermuda grass grown for hay give promising results as to the profitable use of nitrate of soda as a fertilizer for meadows on the stiff lime soil of the Central Prairie region, where commercial fertilizers are not employed because regarded as ineffective by those who have tested their use with cotton or corn. The investigation of the effect of fertilizers on meadows also includes a test with alfalfa.

(6) Johnson grass, a valuable hay plant, becomes a most aggressive weed when out of place, and tests of methods of economically destroying it by the use of chemicals and by other means have been begun.

(7) During the past two years the station has cooperated with the owner of a large herd of native cattle in the endeavor to determine the rate of growth of scrub cattle of different ages during the pasturage season. The station furnishes the scales, the labor necessary in making periodical weighings, and sends its representative to weigh the cattle several times between March and December.

(8) Cooperative tests of forage plants not generally grown are under way, especially with crimson clover, hairy vetch, and alfalfa, to determine (*a*) their adaptability to different soils and (*b*) the need for inoculation, if any, as shown by the absence of tubercles from the roots of these legumes when grown on most soils in Alabama.

How experimenters are selected.—The selection of individuals to conduct the cooperative experiments is made (1) by means of such acquaintance as is afforded when members of the station staff come in contact with farmers at farmers' institutes; (2) upon the recommendation of the man who has previously conducted the test in the locality where a new man is needed; (3) from such of the district agricultural schools as are suitably located and disposed for this work, and (4) from correspondents giving evidence of special intelligence and interest in fertilizer problems.

The present plan of selection is not entirely satisfactory and is doubtless the cause of mistakes that are sometimes made in obtaining a man who has not the confidence of his neighbors or who for other reasons proves unsuitable. The ideal plan would be for a long list of names of eligibles to be obtained in the manner now in vogue, and then to make selections from among these after personal acquaintance made by visiting each farm. This would require that considerable expenditures be made for traveling expenses of one assistant who should spend

a large part of his time in travel for the purpose of selecting the best men and the most suitable fields, in laying out the plats, and in weighing the crop when harvested.

Direction and control of experiments.—All of the cooperative experiments in agriculture and animal husbandry conducted by the Alabama Experiment Station are under the direction of the agriculturist. He selects the experimenters, inviting their cooperation in a letter containing a statement of the terms offered and in a general way of the kind of field needed. Later a mimeograph circular is sent to each experimenter, giving directions as to the choice of land, dimensions of plats recommended, and cultural details. Still later each experimenter is supplied with a small blank book, in which are written the forms which, when filled out, constitute his report. Among the conditions of his experiment, concerning which information is thus elicited, are the following: Exact geographical location, with a view to mapping the location in the proper geological region; slope of field and distance of plats from nearest trees which might unfavorably affect the crop; color and depth of soil and nature of subsoil; history of the land, including time since the removal of the forest, nature of the original forest growth, and statement of the crops occupying the land during each of the three years preceding the year when the test is made; account of the time and method of preparing the land and of applying fertilizers and planting the seed; dates of the cultivation and kind of implement used; notes on diseases and insect enemies, especially noting any variation in the resistance of plants differently fertilized; notes on rainfall and notable climatic conditions; number of plants per plat when practicable; yield of each plat, and such deductions or conclusions as the experimenter may care to draw.

At least two improvements could be made in the direction of these experiments. It is exceedingly desirable that a representative of the station should inspect each cooperative experiment at least twice a year and that an active correspondence be kept up between the station and the experimenter. The supervision of this work, the necessary correspondence, and the travel would require practically all of one assistant's time.

Incentives.—The farmers who have cooperated with the Alabama Experiment Station have served without pay. The station furnishes to each local experimenter fertilizers for eight plats each one-eighth acre in area, prepaying the freight on the same. The total amount furnished is 387 pounds, worth between \$3 and \$4. The absence of compensation insures the getting of men interested in the experiment for the sake of the information which it affords. On the other hand, a farmer who serves without pecuniary reward can not be expected, where other more profitable work needs his attention, to give as much

time to the experiment as it sometimes requires. For example, we desire that the number of plants of cotton growing on each plat be counted, and that then so many be removed as to leave exactly the same number on each plat. This slow work, which brings the farmer no reward, because it does not increase the crop, must be done in the midst of the busiest season.

It is believed that a pecuniary reward should be offered in amount at least sufficient to cover the cost of all unusual labor and the rental value of the land, so that the owner may not be a loser by reason of the failure of certain combinations of fertilizers to afford a profitable crop. It might be well to offer in addition a small bonus to that half of the experimenters whose experiments are most satisfactorily conducted. Too liberal compensation would doubtless have the effect of bringing into the list of volunteers for experimental work some men actuated more by the spirit of gain than by a desire for information.

Thus far we have been unable to consider the question of compensating the local experimenters, because of the small amount of money set aside for cooperative work. In this connection it may be said that whenever this station has had limited quantities of seed desirable for distribution and local trials, preference has been given to the men who cooperate with us in making fertilizer experiments.

It seems scarcely necessary to suggest the need for caution in making distributions of this kind, because of the danger that it may lead some thoughtless men to look to the experiment station as an institution for the distribution of property instead of one for the discovery of new truth and the dissemination of information.

Description of a typical experiment.—The experiment described below illustrates the plan adopted and presents a summary of the results obtained in a single locality. It was conducted by Mr. W. F. Fulton, in Dekalb County, Ala., in 1898, 1899, and 1900. As in all of this class of experiments, 10 plats, each one-eighth acre in area, were employed. The soil is a reddish loam rich in lime. The subsoil consists of red clay.

The table below gives the kinds and amounts of fertilizers, the yields of unginned cotton for each year, and the increase apparently attributable to each fertilizer, the increase being calculated on the assumption that the gradation in the natural fertility of the soil is constant for the plats lying between the two fertilized plats.

Yield oj seed cotton per acre and increase attributable to fertilizers in Dekalb County, Ala.

Plat No.	Fertilizers. Amount per acre.	Fertilizers. Kind.	1898. Yield seed cotton per acre.	1898. Increase over unfertilized plats.	1899. Yield seed cotton per acre.	1899. Increase over unfertilized plats.	1900. Yield seed cotton per acre.	1900. Increase over unfertilized plats.
	Pounds.		*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
1	200	Cotton-seed meal	544	88	648	208	544	....
2	240	Acid phosphate	960	504	760	320	880	336
3	....	No fertilizer	456	....	440	....	544	....
4	200	Kainit	616	142	648	205	666	107
5	200 240	Cotton-seed meal Acid phosphate	1,160	679	880	434	1,120	550
6	200 200	Cotton-seed meal Kainit	768	259	736	287	920	337
7	240 200	Acid phosphate Kainit	992	466	856	404	1,064	468
8	....	No fertilizer	544	....	456	....	608	....
9	200 240 200	Cotton-seed meal Acid phosphate Kainit	1,240	696	976	520	1,208	600
10	200 240 100	Cotton-seed meal Acid phosphate Kainit	....	....	912	456	1,032	424

From the data in the preceding table the fertilizing effects of the cotton-seed meal, acid phosphate, and kainit, respectively, are as follows, the increase for each material under four different conditions being recorded:

Analasis of the increase in yield.

Fertilizer used.	Increase of seed cotton per acre. In 1898.	In 1899.	In 1900.
When cotton-seed meal was added—	*Pounds.*	*Pounds.*	*Pounds.*
To unfertilized plat	88	208	....
To acid phosphate plat	175	114	214
To kainit plat	117	82	230
To acid phosphate and kainit plat	230	116	132
Average increase with cotton-seed meal	152	130	144
When acid phosphate was added—			
To unfertilized plat	504	320	336
To cotton-seed meal plat	591	126	550
To kainit plat	324	233	263
To cotton-seed meal and kainit plat	437	233	263
Average increase with acid phosphate	464	219	378
When kainit was added—			
To unfertilized plat	142	205	107
To cotton-seed meal plat	171	79	337
To acid phosphate plat	38	84	132
To cotton-seed meal and acid phosphate plat	17	86	50
Average increase with kainit	73	116	157

When the data are thus arranged it is clear that the principal need of cotton growing on this soil is for phosphate, which under every condition has largely increased the yield, the average increase for three years being 354 pounds of seed cotton per acre.

This arrangement of the data has the further advantage of confirming or of discrediting the average, for when the four figures which enter into each average do not differ very widely from that average

we may safely assume that no accidental condition has greatly influenced the yield on any one plat. On the other hand, if extremely wide differences exist between the four figures showing the effect of each fertilizer, the results are again carefully scrutinized, and correspondence with the experimenter sometimes follows in the effort to account for the apparent abnormality.

Preparation of the data for publication.—To facilitate the preparation for the printer of the voluminous data afforded by cooperative fertilizer tests two sets of blanks are prepared on the mimeograph. One corresponds in form to the first table on page 500 except that it contains several additional columns, one marked "Calculated yield of each plat if unfertilized;" another, "Value of increase at — cents per pound;" a third, "Cost of the fertilizers," and yet another marked "Profit from fertilizers."

The second blank is in the form given in the second table on page 500, which may be denominated an analysis of the increase in yield. When the little booklet containing the report from each experimenter is received the results are carefully examined, transferred to the two blank forms just alluded to, and conclusions drawn, if any seem justifiable.

If the experiment seems fairly decisive and without contradictions it is published with a full statement as to the kind of soil and the previous history of the field. If the experiment is inconclusive it is nevertheless published as a matter of record, but in this case space and expense are economized by crowding together in one table a number of such inconclusive experiments and by omitting comments and the usual analysis of the results.

Each bulletin giving the results contains a brief statement as to the cost and composition of the fertilizers used and a list of the names of the local experimenters alphabetically arranged. This list also gives the page of the bulletin on which the data of each experiment may be found, together with the county and post-office address of each person making the test.

The data obtained in the uniform tests of the last six years have been arranged in accordance with the following scheme of classification of the results, in which completeness (especially as regards the effects of nitrogen) has been sacrificed for the sake of simplicity:

Group I. Phosphate much more important than kainit; latter not needed or used at financial loss.

Group II. Phosphate much more important than kainit; latter of secondary importance.

Group III. Phosphate and kainit both important and about equally effective.

Group IV. Kainit more important than phosphate; latter of secondary importance, but needed.

Group V. Kainit much more important than phosphate; latter not needed or used at financial loss.

Group VI. Only cotton-seed meal very important; phosphate and kainit of slight or no benefit.

Group VII. No fertilizer used very effective.

This scheme of interpreting the results to the partial neglect of the nitrogen requirements is based on the assumption that a soil's need for nitrogen depends more upon the history and previous cropping of the field than upon the soil area in which the farm is embraced, and that the most important matter is to learn whether potash or phosphoric acid is chiefly needed. The history of the field, together with the size and appearance of the recent crops, gives a clew to the richness or deficiency of the soil in nitrogen, but there is no known means of judging in advance as to the probable need for any one of the mineral elements.

A table giving this arrangement of the most conclusive tests made in 1897, 1898, and 1899 was published in Alabama College Station Bulletin No. 107, page 282. This table, brought up to date, already gives important indications of the relative need for potash and phosphoric acid of the principal soil areas of the State. The accumulated data thus arranged will become increasingly valuable as a guide to practice should a soil survey ever be made of the localities in which these tests have been conducted.

VALUE OF COOPERATIVE EXPERIMENTS.

A cooperative experiment is helpful to the farmer conducting it in pointing out profitable changes in his practice, especially in his selection of the kinds and proportions of commercial fertilizers. It also has an educational effect, raising new questions as to the operations of nature, giving new ideas and a broader outlook on farming, suggesting agricultural possibilities before unthought of, and affording practice in the making of correct deductions from the facts brought to light by the scales and by the appearance of the plants. In modifying farm practice it is helpful to the entire community. For example, a large land owner who is conducting one of these tests writes: "I invite investigation of the experiment by all farmers, especially the negroes, as I wish to educate them as to the kind and quantity of fertilizer to use."

The system of cooperative experimenting could be made much more generally useful to the locality where a test is conducted if funds were available to permit a representative of the station to visit each experiment at least twice a year, and by appointment made in advance meet the local farmers, point out to them in the field the indications afforded by the test, and discuss with each of them other questions of farm practice as they might arise. By so doing the station would be brought into close touch with a large number of farmers, from which mutual benefit would flow.

The cooperative experiment is of value to the experiment station, not only as a means of bringing farmers into close and appreciative relations with the institution, but also as a means of accumulating experimental data otherwise unattainable. For example, questions asked by correspondents as to fertilizers are often answerable from the results of a local cooperative test. The results of a number of such tests considered together constitute the basis for a rough classification of soil areas according to their needs for plant food. The facts brought out by the reports of the experimenters afford information as to the character of local soils, the original forest growth, and the usual local rotations. In no other way can the experiment station more quickly ascertain the adaptability of new crops to certain soils.

Cooperative tests sometimes hint at general truths worthy of investigation under conditions permitting more rigid control. Incidentally cooperative effort may promote agricultural science, but this is not its chief function, for principles are usually to be discovered by deeper researches in the laboratory and on the station farms under the constant surveillance of an expert whose business is discovery. Cooperative experiments do not constitute a satisfactory substitute for substations, for only at these and on the farm at the main station can those extended investigations be conducted which aim at the discovery of fundamental principles or general laws. And even the simplest and most practical problems can be much more definitely solved at a substation, as, for example, questions connected with rotation and with the renovation of worn soils, which necessarily require many years for satisfactory solution.

COOPERATIVE EXPERIMENTS IN ILLINOIS.

By Eugene Davenport,

Director of the Agricultural Experiment Station of the University of Illinois.

ORIGIN AND HISTORY.

Cooperative experiments in Illinois have been the outgrowth of natural conditions. No substations are maintained in this State, and the policy is strongly against scattering the work of the station, as it is also against maintaining any more organization than is absolutely necessary. Accordingly, when this station has gone off its home grounds it has been for a particular purpose and for the reason that favorable conditions did not exist at the station. It has therefore chosen a particular spot for a particular purpose, and the logical corollary of this principle is that it should choose the spot or spots best adapted to the desired end, obtain control of the situation, retain it so long as is necessary, and then abandon it. This is in the interest of carrying on an investigation under the most favorable conditions, then of being freed from it immediately afterwards, to the end that the entire energies of the station may be available at all times for fresh work and not be dissipated in caring for acres whose usefulness is past.

For example, a number of years ago the question of the possibility of tiling the white clay or so-called hardpan lands of southern Illinois came up for discussion. On the one hand it was believed that a large share of the difficulties experienced in farming these lands would disappear with tile drainage. On the other, it was asserted that they were so retentive as to make tile drainage impossible; that water would not penetrate to the depth of tile, but would remain on the surface until removed by evaporation.

There was need of determining facts. Moreover, the determining could be made only upon the spot. This was the first case of the kind that had arisen in the station history, and Professor Morrow met it by going upon the land of the farmer who possessed some of the typical soil, and who was willing that the university should try if it could be drained. In this case the station paid all the expenses but paid nothing for the privilege, the owner taking the chances of damage or benefit.

The trial was entirely satisfactory, but it needed demonstration. It so happened that the field lay remote from the highway, and the writer, to whom had succeeded the responsibility of the experiment upon Professor Morrow's resignation, rented of another farmer a field of especially bad reputation, which, however, had the advantage of lying by the highway, in plain sight of passers-by. Here somewhat extensive experiments were planned on both drained and undrained areas. The work has continued until now and is still in progress, having long since not only tested but demonstrated the practicability of draining these stubborn lands.

This first instance is given in full because it not only serves to show the history and development of the system, but also the cardinal principles under which it has been continued and applied to other lines.

Cooperative experiments in Illinois may be roughly divided into two classes, viz, Class I, in which the station is the chief agent and seeks the cooperation of the farmer because it needs his land or his help in carrying on work which would be otherwise impossible, and which is to determine some general fact or principle; and Class II, in which the farmer is the chief agent, and in which he seeks the help of the station in a matter of interest chiefly to himself and which may or may not be of general interest, but in which the station is willing to render assistance. In Class I the station pays all expenses, has absolute control, and owns all the proceeds. In Class II it pays few or none of the expenses and has slight claim upon results.

Class I.—Manifestly from the station standpoint the most important of the cooperative work comes under Class I. The principles upon which this class of experiments have been arranged and conducted are as follows:

(1) To limit cooperative experiments to definite problems.

(2) To find the spot in the State where conditions are most favorable for answering the particular question that is up, the term "favorable conditions" including not only natural conditions, but also the personal interest of the farmer.

(3) To abandon the spot as soon as the question is answered, or when the problem is shown to be impossible of solution.

(4) That during the progress of the work the owner shall neither profit nor lose by the transaction, and to that end he receives rent for his land at the prevailing rate in the neighborhood, and ordinary pay for all labor he may perform. He does not receive either salary or bonus. The station furnishes everything and has the crop.

The above practically illustrates all cooperative work in which the station in its effort to discover facts of general interest takes the initiative, and in which, therefore, it is the chief active agent.

Class II.—In other cases the farmer asks for help. For this kind of cooperative work the individual rather than the public is the beneficiary; the farmer does all the work, bears all the expense, and has all the proceeds. The station seldom contributes anything but advice and a minimum of materials, usually asking for a report upon general results.

Both plans will be fully illustrated by examples given to show the present status of this class of station work.

PRESENT STATUS OF COOPERATIVE STATION WORK.

Following is a complete outline of cooperative work in progress at the date of writing:

Soil experiments. These are of two classes:

(1) University experiment fields, in which the university is testing the various types of soil of the State and in which the station takes the initiative, incurs all the expense, and has all the results. There are 15 such fields in the State, of from 2 to 15 acres each, located as per the following map (fig. 2), and with a view to including all the prominent types of soil in the State, each of which is subjected to chemical and physical analysis, and is also made the basis of pot-culture experiments.

(2) Cooperative experiment fields, in which the owner is the party chiefly interested; in which the station furnished the plan, with a view principally of helping the farmer solve his problem. Often certain simple materials are furnished also, or obtained for the farmer, as, for example, lime, or infected soil. But the farmer does his own work, incurs all expense, and has all the proceeds. If the results are likely to be of general interest, reports are asked for. There are many of these fields in various parts of the State.

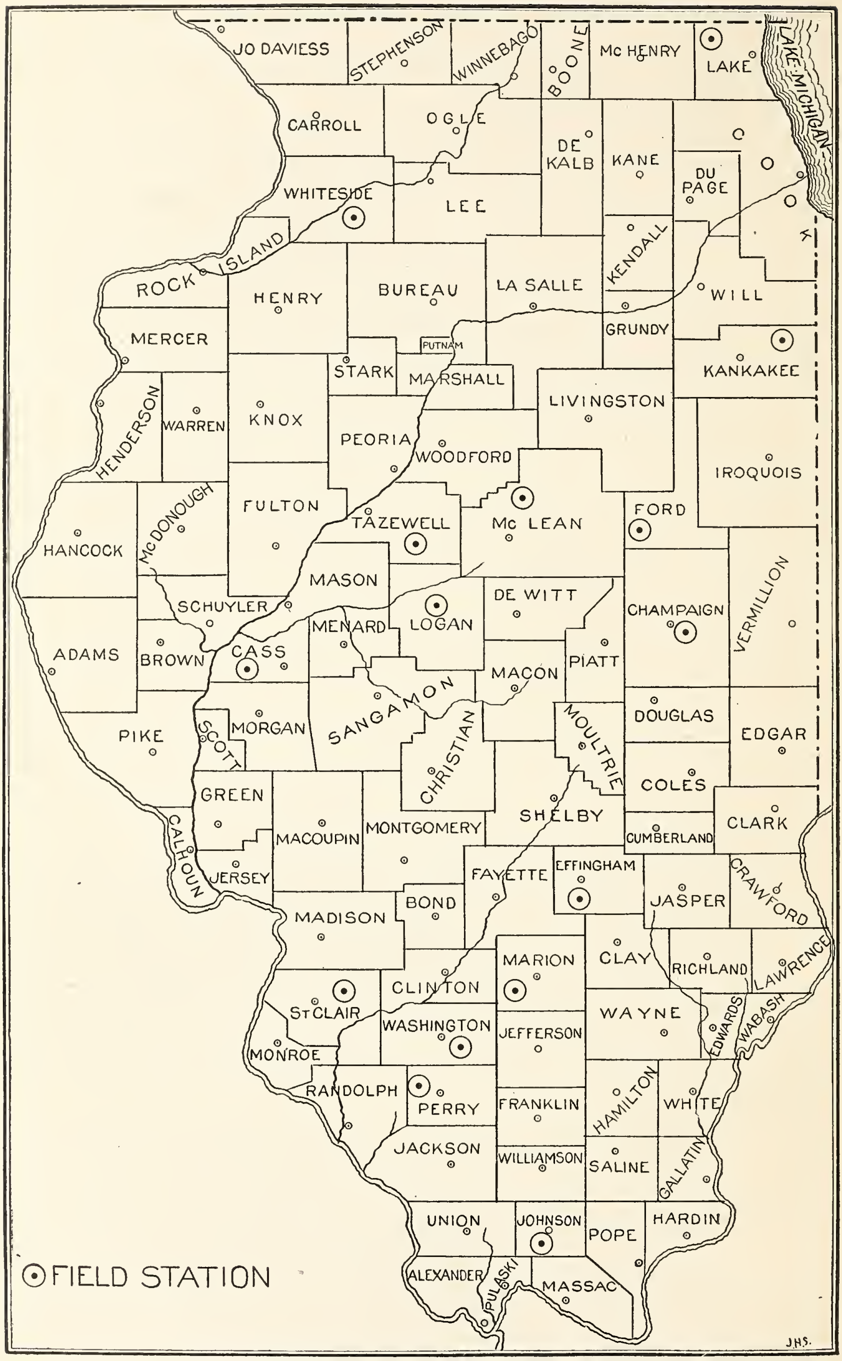


FIG. 2.—Map showing the location of the soil experiment fields thus far established in Illinois.

Crop experiments. Here again are two readily distinct classes of cooperative experiments, as follows:

(1) Cultivation experiments, in which the object is to test various methods of planting, cultivating, and harvesting the crop, and in which the land is rented, and the crop grown entirely under the control of the station and at station expense. These fields are six in number, situated in various parts of the State, and are generally about 10 acres in size. Here the crop belongs to the station and here, as in soil experiments of like character, all such special labor as surveying, applying fertilizers, harvesting, taking of yields, etc., is done by a station employee who visits the fields frequently during the growing season. This plan is used for both Indian corn and sugar beets.

(2) Cooperative breeding. Eight different farmers of the State are interested in breeding corn chemically. They select their seed for physical characters, sending us 200 ears of the sort they have selected to plant. We determine the chemical content and advise them which to plant in a breeding plat for high nitrogen, high oil, etc., as the case may be. Here our labor ends until it is repeated next year.

Mention might also be made of seed distribution. This has been limited to sugar beets. In this instance seed has been sent free, together with directions for growing. Beyond familiarizing a large number of people with the appearance of a new crop it has not seemed effective. It has certainly not secured reliable data and it is doubtful if it has resulted in a disposition to grow the crop. This is from the fact that the strange crop is grown without skill and under conditions not favorable to good results. The use of this form of cooperative work is being reduced to a minimum, with no disposition to extend its application.

Feeding experiments. One experiment with an extensive farmer was planned to test the value of silage in beef production. Here the farmer furnishes the cattle, 50 in number, supplies all feed, and will, of course, have all proceeds. We erect the silo and furnish a man to do the feeding and keep the records. This is a kind of mixture of the two plans heretofore outlined, though nearer the first than the second extreme, in that we do all the significant work and take all the notes and records. It resembles the first class also, in the fact that the information sought is primarily of a public rather than of a private nature.

Dairy experiments. Here also are two classes of work:

(1) The station keeps one man constantly in the dairy region of the State. He is working with the dairymen in testing the cows for their milk, fat, and solids, yield per year, and their food consumption. Incidentally he is coming to be the adviser of many dairymen as to feeding and care of animals, etc. The original purpose of it all was, first, to obtain reliable data as to actual conditions and, second, to lead the dairymen to study their own conditions more closely and inquire

more carefully into their business. All this required the most generous assistance of the farmers themselves, and it is thus joint work in the best sense of the term. It classifies fairly with the first class of cooperative experiments described.

(2) Testing cows. Aside from the above, and entirely distinct from it, the station sends men to test private herds when requested to do so. This is entirely at the expense of the owner, and the value of the work is exclusively his. This class of work, therefore, is of the same order as the second class mentioned in other lines, in that the chief advantage is to the individual, who also incurs all of the expense.

Horticultural experiments. Here, as in other lines, two distinct classes of cooperative work are in progress:

(1) Experiments in the cold storage of apples in specially insulated and artificially cooled cellars are in progress upon three of the larger fruit farms of the State. As in all others of this class, the station incurs all the expense, but in this case the owner furnishes the fruit and takes his own chances of success or failure. One warehouse was erected at Neoga at an expense of $3,000. It had a capacity of 2,500 barrels, and was cooled with ice. All expenses of building, icing, and care were borne by the station, but the fruit was contributed by individual apple growers. No charges were made for storing and the owner accepted all risks of loss or damage during the experiment. The house was opened for withdrawal of fruit on stated days and on no others.

Extensive experiments have been in progress during the last two years to learn whether bitter rot could be controlled by spraying. These have of necessity been on orchards where the disease has made its appearance, and they have been cooperative in the sense of others of Class I, except that the station accepted no responsibilities as to the crops, because in this instance the crop was in hazard and the experiments were not of such a nature as to increase the danger of loss.

Cultivation experiments have been in progress in many orchards of the State, as have also others intended to test the efficiency of cover crops.

(2) Demonstration experiments, in which the object is not to learn new facts, but to employ the form of cooperation for the sake of more rapidly and thoroughly demonstrating to a community the efficacy of spraying for ordinary insect and fungus enemies. The same plan is now being followed as to cultivation and cover crops.

NUMBER OF EXPERIMENTERS.

The number of individuals involved in these cooperative experiments is not large, except in the seed distribution, which includes about 500. Aside from these the total number with whom cooperative work

of all forms is conducted would not exceed 100. Under Class I, in which the cooperation on the part of the farmer is slight and in which the station is the principal agent, the number will never be large; but under Class II, in which the individual is the principal beneficiary, the number is much larger and shows a decided tendency to increase.

HOW THE COOPERATION IS SECURED.

This is accomplished in various ways. The two requisites are (1) local conditions that are suitable, and (2) a farmer that is interested. The former is known from our knowledge of conditions or is ascertained by special inquiry and verified by personal examination. The latter is generally known by our correspondence or from personal acquaintance. Indeed, work of this kind is mostly confined to those who know something of the nature of experimental work and feel an interest in it. In every case these are progressive farmers and in no case is the money recompense sufficient to become an impelling influence.

Without exception these are men who realize the larger reasons back of investigation work, and it is this that wins their interest; indeed in few cases would they be willing to cooperate for the money consideration alone. This being true, these individuals are not difficult to find, even when the cooperation is sought by the station, while in Class II they announce themselves and solicit cooperation because of the advantage to them as individuals.

CONTROL OF COOPERATIVE EXPERIMENTS BY THE STATION.

So far as experiments of Class I are concerned the control by the station is absolute. Under the lease the cooperator surrenders for the time all rights to his property, and he or whoever performs work for the station simply follows directions. Here the conditions are no different than if the experiment were upon our own grounds. I can not, however, emphasize too much the value of the good will of these farmers. This constitutes a valuable asset to us, and is not the least valuable feature of this class of cooperative work.

Control is accomplished by direct and frequent visitation. Indeed the more particular work, such as platting, applying fertilizers, taking weights, yields, and records, is all done by station employees themselves. Ordinary work is done by the owner, or some other farmer, as has been arranged, but under the absolute direction of the station.

In the case of Class II there is no control by the station. It furnishes a plan, gives assistance and advice, but does not dictate, because the case is primarily an individual matter. It may be proper to remark here that the purpose of experiments of this class is not so much to

assist individuals as to encourage the spirit of investigation among progressive farmers, and to avail ourselves of what has been found to be the most powerful known means of dissemination.

In these experiments the visitation, if made at all, is by request, and in such cases the station limits itself to advice. This is the way it appears on paper, but the fact is that in both classes of cooperative experiments there is close conference, very great freedom of suggestion, and mutual helpfulness. In all cases every effort is made to get out of the work as much benefit as possible to both parties.

INCENTIVES TO COOPERATION.

In Class II the incentive is clearly a business one, resting on the belief that personal advantages will follow. In the case of Class I there is no incentive except that of "public spirit" and interest in the subject. The cooperator is advised at once that the station will undertake to insure him against loss, but that, on the other hand, he will not be a gainer, financially, by his cooperation unless, of course, something should be discovered that will be especially useful to him. Most men are willing to do something for the public, especially when they learn that they control natural advantages. As such control is not absolutely with a single man, it is not difficult to find those who are willing to suffer some inconvenience pro bono publico. Besides, the question being one peculiar to the locality, it is generally one in which the owner feels an interest and frequently a very keen interest. In practice it has been found that no special "inducements" are necessary, but that the need of information is sufficient incentive. When farmers will visit the legislature at their own expense to urge the appropriation of funds for experiments to answer some of the difficult questions in the agriculture of the State, there is already an interest that needs no special incentive to cooperation.

COST OF THE WORK AND HOW MET.

This topic has been already fairly well covered. In Class I the station defrays all expenses, paying only ordinary rates. In Class II the owner does all the ordinary work, and the station whatever scientific work is involved or whatever arises that is out of the ordinary. Manifestly, cooperative work of Class II must be limited to lines in which the station is already at work and its assistance to extraordinary, though to us nominal, matters. Our energies go principally into Class I.

Speaking generally, the cost of cooperative work of either kind is not excessive; indeed, all things considered, it is the least costly class of investigation conducted by the station.

DETAILED DESCRIPTION OF TYPICAL EXPERIMENTS.

The plan and scope of the cooperative work will perhaps be better understood by a detailed description of a particular experiment under each class outlined.

The fifteen university soil-experiment fields are good examples of cooperative experiments described as Class I. These fifteen fields were located upon farms of men interested in soil investigation, and so distributed as to be representative of the various distinct classes of Illinois soils, as follows: (1) The wheat lands of the southwestern portion of the State; (2) the hill soil of the extreme south; (3) the peculiar white clay soil of the south central section north of the Ozak Hills; (4) the black prairie soil of the central or corn belt; (5) the sandy soils near the Illinois River; (6) the swamp lands in the northern portion of the State, and (7) the hill soil in the extreme north.

As for the detailed plan of these experiments, I quote from Dr. Cyril G. Hopkins, who has them in charge:

The general plan of these soil-experiment fields is well illustrated by the plat of the Sibley Experiment Field, which consists of four 1-acre plats staked off so that each acre is divided into ten equal parts of 16 square rods each, being in form 2 rods wide by 8 rods long. Each tenth acre is separated from its neighbor by a strip of land ½ rod wide. This arrangement is made so that each plat will be wholly separated and independent and so that any fertilizer distributed or other treatment applied to one plat will not affect the growth of plants on an adjoining plat. These intervening spaces also serve the purpose of turning spaces for teams during cultivation. By this arrangement of plats the amount of land needed to secure 4 acres of experimental ground is a piece of land 42 rods long by 28½ rods wide or about 7⅓ acres. The plats of each acre are numbered in the same manner, those of each acre beginning with 101, 201, 301, and 401, and are known by their serial numbers. Series 200, 300, and 400 constitute a three-year rotation of corn, oats, and some leguminous crop. By using 3 acres, each crop will be grown each year, that is, each year there will be an acre of corn, an acre of oats, and an acre of legumes growing.

Besides using a leguminous crop in the rotation, it is also the intention to use a leguminous crop as a green fertilizer; for example, on plats 202, 204, 206, 208, either cowpeas or soy beans will be sown in the corn when it is cultivated the last time in 1902, and in the corresponding series 302, 304, 306, 308, either clover will be sown with the oats or some other leguminous crop will be sown immediately after the oats are harvested. In order to make a comparison and, if possible, determine the relative value of manure as compared with leguminous catch or cover crop, manure will be used on plats 203, 205, 207, 209, and the corresponding plats in 300 and 400 series. Besides this, in each series in the three-year rotation there will be the comparison in plats 202 and 203 of legume against manure without other fertilizers, then in plats 204 and 205, there will be the comparison of legumes and lime against manure and lime. In 206 and 207 the legumes, lime, and phosphorus will be compared with manure, lime, and phosphorus. In 208 and 209 legumes, lime, and potassium will be compared with manure, lime, and potassium. Plats 201 and 210 are check plats, 201 having no fertilizer whatever and 210 having all three mineral fertilizers applied, but without either manure or a leguminous catch crop.

The object of this three-year rotation of crops in three series of plats is to determine as far as possible how much of the nitrogen of the air may be brought to the soil as plant food by the use of leguminous plants both in a regular rotation of crops

and also by the use of leguminous plants as a catch crop sown when laying by corn and with or after oats, and also to determine if the waste of plant food in the soil by cultivation and cropping may be retarded or perhaps wholly checked by a systematic rotation of crops.

Plat of Sibley Experiment Field.

110	109	108	107	106	105	104	103	102	101
									None.
	Lime.	Lime.	Lime.	Lime.	Lime.	Lime.	Lime.	Lime.	
Nit.	Nit.		Nit.	Nit.			Nit.		
Phos.	Phos.	Phos.		Phos.		Phos.			
Pot.	Pot.	Pot.	Pot.		Pot.				

210	209	208	207	206	205	204	203	202	201
									None.
		Legm.		Legm.		Legm.		Legm.	
	Manr.		Manr.		Manr.		Manr.		
Lime.	Lime.	Lime.	Lime.	Lime.	Lime.	Lime.			
Phos.	Phos.	Phos.	Phos.	Phos.					
Pot.	Pot.	Pot.							

310	309	308	307	306	305	304	303	302	301
									None.
		Legm.		Legm.		Legm.		Legm.	
	Manr.		Manr.		Manr.		Manr.		
Lime.	Lime.	Lime.	Lime.	Lime.	Lime.	Lime.			
Phos.	Phos.	Phos.	Phos.	Phos.					
Pot.	Pot.	Pot.							

410	409	408	407	406	405	404	403	402	401
									None.
		Legm.		Legm.		Legm.		Legm.	
	Manr.		Manr.		Manr.		Manr.		
Lime.	Lime.	Lime.	Lime.	Lime.	Lime.	Lime.			
Phos.	Phos.	Phos.	Phos.	Phos.					
Pot.	Pot.	Pot.							

The series of plats in the acre numbered 100 represents what is termed the straight fertility test, or experiment in which a complete test of all the important elements of fertility in the soil is made; in other words, this test is designed to determine if any element of plant food is deficient in the soil. This will be accomplished by adding the different elements of fertility singly and in combination to the several plats, the effect of which will be shown in the growth of the crop to which this acre

is planted. For instance, if potassium is deficient in the soil, those plats to which potassium is added should produce an increased growth over those plats to which this element had not been supplied. The first year of the experiment should indicate what elements of plant food, if any, are deficient in the soil, though the experiment should be continued with the same crop for two or three years in order to determine what effect the application of these different elements of fertility will have upon the soil.

The above plat will make clear the plan adopted of testing the soil as to the elements of fertility, both in rotation experiments and in "straight fertility tests." It should be understood that samples of soil from these fields are subjected to both chemical and physical analyses and are employed also in extensive pot-culture experiments at the station.

As has been already indicated, upon all these fields the station not only rents the land but pays for common labor, all at prevailing rates for that neighborhood. It performs all unusual work by its own employees, furnishes all fertilizers, seed, and special tools, and owns all crops produced. It takes its own records, and the experiment is in every way under station control as much as if situated on our own premises.

Cooperative experiments of the second class are best illustrated by the cooperative work with G. H. Perrine & Sons, Centralia, Ill.

These gentlemen desired to know what fertilizers, if any, should be applied to their apple orchards. An old planting consisting of 27 rows was divided into 10 plats, each consisting of 1 row with the spaces upon either side and treated as follows:

Experiment 1, rows 2 and 3: Cowpeas in space between and on either side.

Experiment 2, rows 5 and 6: Cowpeas and lime on space between and on either side.

Experiment 3, rows 8 and 9: Cowpeas, lime, and phosphate on space between and on either side.

Experiment 4, rows 11 and 12: Cowpeas, lime, phosphate, and potash on space between and on either side.

Experiment 5, rows 14 and 15: Cowpeas, lime, phosphate, potash, and farmyard manure on space between and on either side.

Experiment 6, row 18: Lime, phosphate, potash, and farmyard manure on either side.

Experiment 7, row 20: Lime, phosphate, and farmyard manure on either side.

Experiment 8, row 22: Lime and farmyard manure on either side.

Experiment 9, row 24: Farmyard manure on either side.

Experiment 10, rows 26, 27: No treatment, check.

In these experiments the plan was supplied by the station, which also furnished the potash and a drill for sowing the fertilizers. The lime and phosphate were secured by the station, but at the expense of the

owners, who also performed all the work. It is worth stating incidentally that the station was able not only to secure these fertilizers for the parties at greatly reduced rates, but also to provide for their transportation without charges for freight or hauling.

This being a large orchard, the experiment is the most extensive that has been undertaken with a view of ascertaining the fertilizer most needed for the apple when growing on the soil of southern Illinois. It will thus have a wide application, although it was undertaken as a guide for the future policy of these parties upon their other and younger orchards.

VALUE OF COOPERATIVE EXPERIMENTS.

(1) To the station their value is twofold. First of all, by this means it comes immediately into possession of conditions that would require years of time and large outlay of money to produce, even if it were always possible to secure them on the station grounds, which it is not. If experiments are to be conducted upon the various distinct types of soil, we must first find them, then go where they are to carry on the experiments, except so far as pot cultures and analyses are concerned. There are but two ways of doing this. The one is to resort to some sort of cooperation with the man who owns the spot where conditions are most favorable; the other to establish a substation there and proceed to produce the conditions not offered under nature, as, for example, an old orchard. All this takes time and money to get ready to begin, besides the fact that the administration of a substation is fraught with difficulties, and its discontinuance is often embarrassing. In cooperative experiments no burdens are assumed except those connected at the time with the particular questions to be answered. Thus responsibility is reduced to a minimum and, what is of equal significance, the thing can be dropped easily and naturally when the question is answered.

All this is intended to refer to cooperative work that is carefully planned and seriously undertaken after a full understanding by all parties of all that it will mean. Pseudocooperation without definite plan and full understanding such as is involved in free seed distribution with directions for growing and requests for report is not meant to be included in this estimate of the value of cooperative work. In the nature of the case large numbers will not be involved where good work is done; and another fundamental is that station employees themselves perform all unusual work, take all the records, and make all the reports. It may be called station extension, perhaps, rather than cooperative work, but after all the cooperative element is large and important.

A second advantage to the station in cooperative work is that what is carried out upon the farms of the State is already demonstrated and on the road to adoption by the people. This is because the progress of the experiment is watched by somebody and its teachings will be put into immediate use by at least a few, who not only believe in it, but who also know a good deal as to how to go about it.

The chief difficulty in introducing a new practice is to get it started—to find the first few who will undertake it and who can be made to give the matter enough initial study to know how to go about it in a way to succeed. Some of the best findings of science have thus failed to affect practice because the station did not follow them up.

So true is all this that the Illinois Station often avails itself of the form of cooperation even when the only object is to introduce a practice. In this way the farmer feels a certain responsibility as well as initial interest and does not "lie down" upon the institution as he does when he feels that he is being taught just how to do a thing that after all is of doubtful utility.

(2) The advantage of cooperative work to the farmers themselves is, first, that they become familiar with the conditions during the progress of the experiment, and, this being so, its application to practice is comparatively easy. It is always difficult to do a thing the first time, even if the operation be the simplest. One of the best fruit growers of a large State became convinced that he should spray his fruit trees. After securing his pumps, tanks, and materials for spraying mixtures, he sent 50 miles for a man to come "to do it the first time, because he had done it."

Another advantage to the farmer is that he becomes somewhat familiar with experimental work and is less likely to conduct a large number of experiments (?) on his own account, but on the contrary he becomes a more accurate observer and a closer student of conditions. He is therefore more likely to modify his practice along desirable lines and less likely to follow a multitude of "suggestions" from unknown or unreliable sources.

(3) As a means for promoting agricultural science, it is limited to its usefulness to the station in providing it with data not otherwise obtainable and to the additional fact that by the means of cooperation the results of scientific work become more rapidly and thoroughly diffused among the people.

It is needless to say that the greatest care must at all times be exercised by the station in conducting cooperative work. Reports sent in by cooperators, like yields and records taken by them, are not reliable; that is to say, there are so many errors as to invalidate the whole because they can not be separated from the correct data. On the other hand, if cooperation be limited, as it should be, to leading farmers, they can be depended upon to perform ordinary operations thoroughly.

In other words, cooperation should be defined so as to leave on the side of the station the whole duty of everything peculiar to experimental work and on the side of the farmer only that in which he already possesses skill.

To send a pound of beet seed to an unknown farmer and ask him to report the yield is to invite error, and we need not be surprised to get reports of 75 and 80 tons to the acre, especially when we know that the chances are that he will plant a single row 20 or 30 feet long on the best spot in the garden. Such work as this, for which the station is primarily at fault, should not be used as argument against cooperative work between stations and farmers, which if properly planned and executed is the most effective method known of combining investigation and demonstration.

COOPERATIVE EXPERIMENTS IN NEW YORK.

By J. L. Stone,

In Charge of Experiments in General Agriculture.

ORIGIN AND HISTORY.

The cooperative experiments conducted in New York State by the College of Agriculture of Cornell University are a part of the extension work in agriculture sustained by means of appropriations made by the State legislature. Their development has been simultaneous with that of other branches of the work. It will be necessary therefore in tracing their history to notice the origin and growth of the extension work in agriculture. The movement at its beginning was restricted to horticultural investigations and instructions and to a single judicial department of the State, but has since grown to include the entire State and embrace agriculture in general.

The law under which the extension teaching of agriculture is now being prosecuted by the college was at first an experiment-station measure. The bill originated entirely with the people, when, in 1893, certain Chautauqua County grape growers asked the station to undertake experiment work in their vineyards. It was replied that while the station would like to take up the investigations, its funds were insufficient to meet the expense without endangering work in which it was already engaged, and this lack of funds would be keenly felt if other sections of the State, following the Chautauqua example, should also ask for help. It was suggested, therefore, that if their local horticultural society could raise sufficient funds to meet the expense of fertilizers, traveling, and incidentals, the station would try to detail a man to look after the work. The matter dropped there, but the next winter a movement was started among the Chautauqua people to obtain a small State appropriation to pay for experiment work in their vineyards. A grant of $16,000 was obtained, one-half of which was

to be expended by the Cornell Experiment Station in work in horticulture in the fifth judicial department of the State, an area comprising sixteen counties of western New York.

The clause in the law of 1894, which appropriated money to the Cornell University Experiment Station, is as follows:

> The sum of eight thousand dollars, or so much thereof as may be necessary, is hereby appropriated, to be paid to the agricultural experiment station at Cornell University, for the purpose of horticultural experiments, investigations, instruction, and information in the fifth judicial department, pursuant to section eighty-seven of the agricultural law.

The law also provides that—

> Such experiment station may * * * appoint horticultural experts to assist such experiment station, in the fifth judicial department, in conducting investigations and experiments in horticulture; in discovering and remedying the diseases of plants, vines, and fruit trees; in ascertaining the best means of fertilizing vineyards, fruit and garden plantations, and of making orchards, vineyards, and gardens prolific; in disseminating horticultural knowledge by means of lectures or otherwise, and in preparing and printing for free distribution the results of such investigations and experiments, and such other information as may be deemed desirable and profitable in promoting the horticultural interests of the State. * * *

This bill became a law by the governor's signature May 12, 1894. In the legislature of 1895 a bill was introduced to continue the work, but increasing the amount given to the Cornell University Experiment Station to $16,000. This second bill became a law on April 4, 1895. A third and similar appropriation, also for $16,000, was made by the legislature of 1896.

Upon taking up the work provided for by the bill, in the early summer of 1894 the Cornell University Experiment Station laid out three general lines of work, as specified in the law—"conducting investigations and experiments," "disseminating horticultural knowledge by means of lectures or otherwise," and "preparing and printing" the results of the work. In other words, the work was to be divided between research, teaching, and publication.

The enterprise was new and untried; the territory to be covered was large, the interests varied, and the demands numerous; the promoters of the bill had large expectations of the results. The responsibility of inaugurating the enterprise was keenly felt, for a mistake in the beginning might be expected to exert a serious and baneful influence upon future legislation designed to improve the conditions of rural life. It was conceived that in the beginning a comparatively small and well-digested enterprise prosecuted by a few carefully chosen men would be productive of better results than any bold attempt with a large force to carry the work into every part of the fifth judicial department. Inasmuch as the original grant was obtained through the exertions of the grape growers of Chautauqua County, it was designed to undertake careful studies of the vineyard interests at the outset.

During these first three years the experimental work consisted chiefly of investigations of certain insect and fungus diseases affecting the vineyards and orchards of western New York, seeking remedies for the same, and making field demonstrations before companies of farmers of the methods of applying the remedies. More than sixty readable, expository bulletins were published, numerous so-called horticultural schools were held, and a beginning was made in work in the public schools, which has since developed into the nature-study movement.

The legislature of 1897 made a fourth appropriation for carrying on the work, but the terms of the law were so changed that it applied to the entire State and to agriculture in general. Moreover, it was given to the College of Agriculture (not to the experiment station) for "the promotion of agricultural knowledge in the State." For this purpose $25,000 was appropriated. The attachment of this fund to the College of Agriculture signalized the outgrowth of the work from mere experiment (as chiefly contemplated at first) into the general promulgation of agricultural knowledge. The work was extended and broadened, and an increase in staff was made.

Succeeding legislatures have continued the appropriation, and for several years the amount has been $35,000.

PRESENT STATUS OF COOPERATIVE EXPERIMENTS.

The work as now conducted for "the promotion of agricultural knowledge in the State" may be classified under six general heads:

(1) The cooperative experiments as a means of investigation and instruction.

(2) The farmers' reading course.

(3) The farmers' wives' reading course.

(4) Instructions in nature study for pupils and teachers of the public schools.

(5) The winter courses in general agriculture and in dairy husbandry.

(6) Publication of literature used in the work and of bulletins giving results of investigations.

In this extension work the effort has been not so much to discover new facts as to find some way of driving home the old facts. We have endeavored to set forces at work that would silently extend themselves when we had left them. Fortunately for our purpose, we have been greatly aided by the agricultural depression of recent years and the multitudes of insects and special difficulties that have appeared. These things have driven the farmers to more definite thinking and to asking for information. The agricultural communities are aroused and in a teachable mood. When one is thoroughly prosperous in his business there is little chance, as in fact there is generally little need, of teaching him other methods.

Turning our attention, now, more specifically to the cooperative experiments as conducted in the State of New York, we remark that the system is an outgrowth of existing conditions and needs, and not an effort to put into execution preconceived schemes or to adopt methods that have elsewhere proved successful. The chief thought at the start was to conduct investigations that might lead to a solution of some of the many problems confronting the farmers and fruit growers in their practical work. Very much has been accomplished right along this line, as will be shown later, but as members of the college and station staff went among the farmers in carrying on their investigations they were impressed with the fact that comparatively few of the farmers were adopting in their practice the suggestions of the experiment station, which suggestions were based upon results obtained on the home grounds and published in numerous bulletins. Inquiry brought out the fact that many of them had not read the bulletins and reports, but of those who had, many were inclined to give little weight to results obtained at the station, especially if somewhat contrary to their traditional teaching. A common remark when an improved method was suggested for trial was, "Well, that may be all right for you people, but it would not work that way here." Without in any degree losing sight of the importance of investigating the many unsolved problems in agriculture, we became profoundly convinced that the means employed to communicate to the farmer the results of investigations and to induce him to adopt methods that have been proven valuable by the stations are not adequate. The farmer is not deriving the benefit he should from the investigations conducted in his behalf. What means can we employ to bring the teachings of improved agriculture effectively to his attention?

There is, of course, always a question whether the conclusions based upon experiments in a given locality and on a certain soil apply to other soils and localities. We have, therefore, asked the farmers to aid us in determining whether methods and varieties found advantageous at Ithaca will prove to be so on their farms. We find them much more inclined to try new varieties than to test improved methods of tillage. Nevertheless we have induced many to try, as an experiment, methods in which they at the beginning had no faith, but found so advantageous that afterwards they were adopted for general practice. Probably at the present time as many of our experiments aim simply at bringing forcibly to the farmers' attention desirable methods or varieties as seek to acquire new data relating to agricultural problems.

Some of the lines of experimentation that have been followed either for investigation or instruction, or both, may be named as follows:

(1) Spraying as a means of combating the insect and fungus enemies of vineyards, orchards, and field crops.

(2) The tillage of orchards and vineyards.

(3) The sugar-beet crop.

(*a*) Testing the adaptation of soil and climate to sugar-beet growing.

(*b*) Testing varieties of sugar beets.

(*c*) Securing data as to the cost of growing sugar beets.

(*d*) Testing the effect of different chemical fertilizers on the yield and quality of sugar beets.

Upward of 500 farmers have engaged in experiments with sugar beets in a single season.

(4) Experiments with commercial fertilizers.

In the main the following scheme has been used:

Plat 1, K, 15 pounds muriate of potash.
Plat 2, N, 20 pounds dried blood.
Plat 3, P, 30 pounds acid phosphate.
Plat 4, no fertilizer.
Plat 5, NK, 35 pounds of mixture of { 20 pounds dried blood. 15 pounds muriate of potash.
Plat 6, PK, 45 pounds of mixture of { 30 pounds acid phosphate. 15 pounds muriate of potash.
Plat 7, NP, 50 pounds of mixture of { 20 pounds dried blood. 30 pounds acid phosphate.
Plat 8, NPK, 65 pounds of mixture of { 20 pounds dried blood. 30 pounds acid phosphate. 15 pounds muriate of potash.

More than 150 farmers have undertaken this experiment in a single season. At the beginning the station supplied the fertilizers for experiment. Later, when interest in the work had become established, arrangements were made whereby the farmers could secure the sets for experiment at about the cost of the chemicals.

(5) Wheat.

Tests of varieties that have proven valuable on the station grounds or at certain places in the State.

(6) Beans.

Tests of varieties, methods of culture, and the effects of different fertilizers.

(7) Potatoes.

Tests of varieties and of different methods of culture.

(8) Buckwheat.

Varieties and methods of culture.

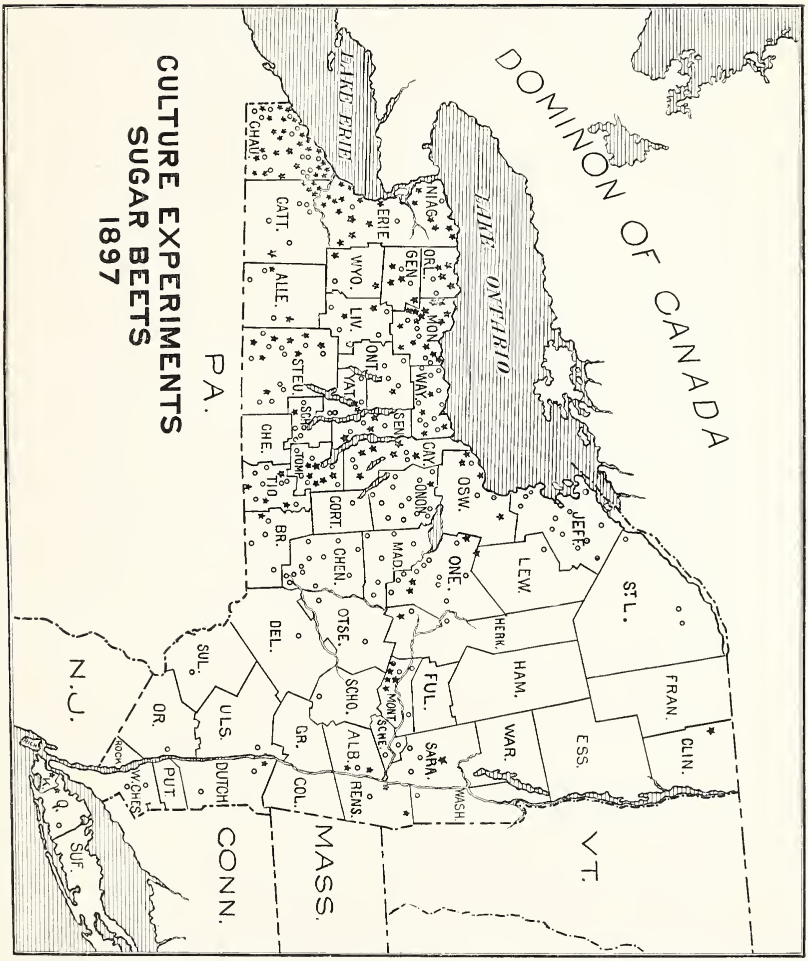
(9) Alfalfa.

A study of the crop as grown in the State of New York and the conditions of success and failure.

(10) Soil renovation.

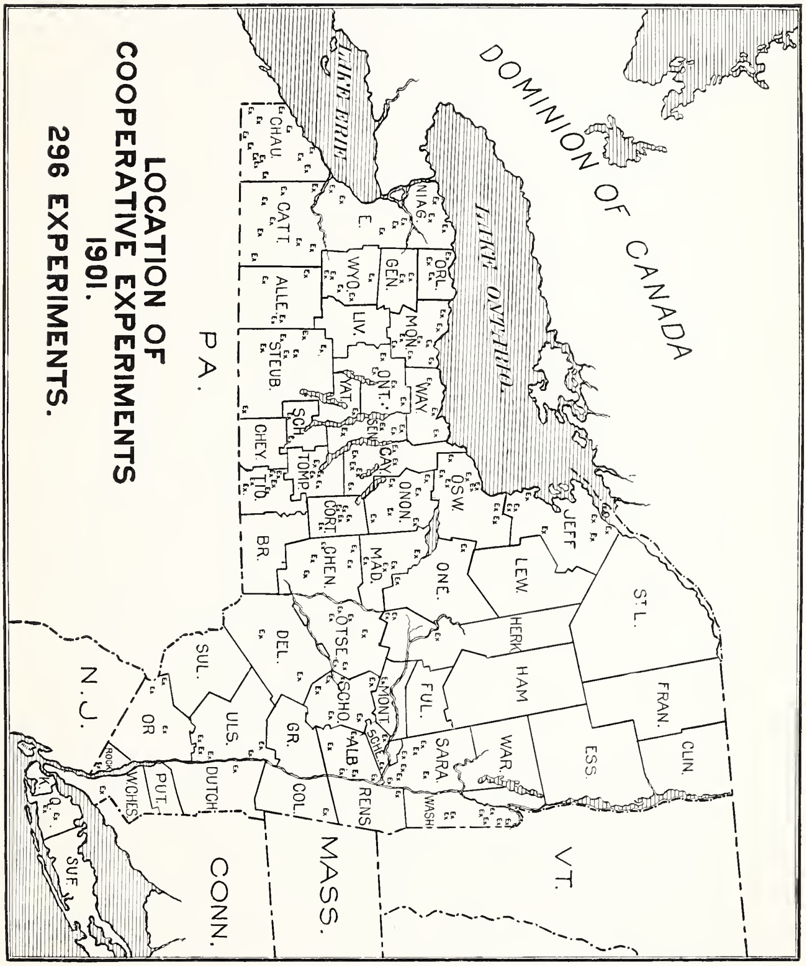
Experiments on depleted fields with various green-manuring crops to ascertain which are best adapted to the renovation of certain soils.

(11) Cover crops.



Map Showing the Location of Cooperative Experiments with Sugar Beets in New York.

HARVESTING AND WEIGHING POTATOES ON COOPERATIVE EXPERIMENTAL PLATS IN NEW YORK.



Map Showing the Number and Location of Cooperative Experiments in New York.

For fruit yards and orchards. An effort to find the crop most suitable to different soils and conditions.

(12) Cabbage.

Methods of tillage, kinds of fertilizer best adapted, and a study of varieties.

(13) Shading experiments.

Growing vegetables and small fruits under cheese cloth.

(14) Rotation experiments.

A study of the physical and chemical effects upon soils of rotations, including several leguminous crops and others composed of non-legumes.

HOW COOPERATION IS SECURED.

At the beginning cooperation of the farmers was secured by personal solicitation. The bicycle has been much used in New York to get in touch with the farmers of the State. The man on a wheel seeks the man on the farm. Since the work has become well established it has not been necessary to make a personal canvass to secure offers of cooperation. A notice of the proposed lines of work inclosed with the bulletins or reading course lessons has put us in communication with the farmers. The personal visit, in the main, is reserved until the experiments are under way. Very little money has been paid to the farmers for experimental work. In a few cases when the experiments were investigational in character, and it was desired that they should be located at certain points, we have arranged to pay for labor required in harvesting plats so as to be able to estimate yields. A considerable proportion of the experimenters with whom such arrangements have been made have, in the end, contributed the work, saying that they were already well paid in the information gained and in the pleasure derived from the work.

HOW THE WORK IS DIRECTED.

Effort has been made to have the plan of the experiments as simple as possible. More stress is laid on having the various plats of uniform area than that they should constitute a certain fractional part of an acre. It often is easy for a farmer to take a certain number of rows across a field (corn or potatoes) for a plat when it would be inconvenient for him to lay off an exact area, as one-tenth acre. Instructions including tables of figures and facilitating the estimation of yields per acre from small measured areas are furnished the experimenters. While all is done that can be to make the work simple, the details of the arrangements are left as much as possible to the farmers, who can adjust them to the local conditions.

DETAILED DESCRIPTION OF TYPICAL EXPERIMENTS.

(1) As an example of an experiment that is purely instructional, the plan of which was suggested by results obtained on the Cornell Station grounds, the tillage experiments with potatoes may be taken. This experiment permits of being broken up into six separate parts, and in case the farmer can not secure all the conditions suggested he may make a combination of some of them. The following is an extract from the circular of instruction:

EXPERIMENTS SUGGESTED IN THE TILLAGE OF POTATOES.

It is thought best to state the suggestions of the station regarding the work under six different heads, so that each farmer may readily select one or more of them for experiment, according as his circumstances will permit.

1. *Autumn v. spring plowing.*—There may be soils where autumn preparation will not be advantageous, but it is believed that in many localities where fall plowing is not practiced it will prove to be very beneficial, and it is desired to have the experiment tried on small areas and results reported to this station.

2. *Twice plowing v. once plowing.*—As soon as the field is cleared of the previous crop, whether it be in sod, stubble, or fallow; plow the land as deeply as the character of the soil will permit, and work it down well with the harrow and roller. If in August, sow crimson clover, unless this crop is known not to succeed in the locality. If after August sow to rye or wheat. This autumn tillage will develop much plant food which the growing plants will take up and hold in readiness for next season's crop. If crimson clover is grown it will also gather nitrogen from the atmosphere. (See Bulletin 135, p. 296.)

As early in the spring as the land will work plow the area, but not quite so deeply as recommended for the autumn plowing. At intervals of eight to fifteen days from the date of this early plowing till planting time, as the weather will permit, work the ground thoroughly with spring-tooth harrow or cultivator, thus killing several crops of young weeds, developing much plant food, and preventing the loss of moisture by evaporation. Sometimes it is an advantage to delay the planting, that the land may receive another thorough working before the seed is put in.

This double working of the land—autumn and spring—coupled with the growing of a catch crop, as circumstances permitted, is believed to have contributed more toward securing such unusual average yields on the station grounds than any other part of the treatment the land has received.

Compare this double-worked land with an area that has been worked but once, either autumn or spring, as circumstances make convenient.

3. *Early v. late spring plowing.*—Plow an area as early in the spring as the land is fit to work and treat it till planting time as in No. 2. Compare this with another area plowed and fitted just before planting.

4. *Deep planting and harrowing before plants are up v. shallow planting and without working till plants are well up.*—At planting time, whatever the tools or machinery used in doing the work, endeavor to secure the conditions that are obtained by the following plan:

Open up with a double moldboard or shovel plow, at appropriate distance (presumably at about 36 inches), furrows 4 or 5 inches below the general level, throwing the earth up in ridges between the rows. Place the seed in these furrows at from 14 to 18 inches between the pieces. Then split the ridges, forming new ridges over the seed, which will be buried deeply, with furrows between the rows. Observe

that the soil has thus all been thoroughly stirred to a depth of 4 or 5 inches. In about a week after planting level down the ridges by means of a spike-tooth or smoothing harrow. This harrowing may be repeated, perhaps several times, before the plants are up.

Compare this area with another furrowed with a corn marker or other shallow working implement. If desired this area may be check rowed, the difference in the amount of seed used being charged against the thicker planting.

5. *Prolonged frequent level tillage v. "laying by" at third cultivation.*—As soon as the rows can be followed, cultivate the space between them as deeply as it can readily be worked, keeping away from the plants sufficiently not to disturb their connection with the soil. This is the last deep cultivation the crop will receive. From this time on, at intervals of ten to fourteen days, cultivate lightly (about 2 inches deep), working as close to the rows as the size of the tops will permit. Cultivate after every rain storm as soon as the soil is fit. Continue these shallow cultivations so long as it is possible to pass between the rows, narrowing the cultivator at each successive tillage to correspond to the space that is left between the spreading tops. A little earth will be thrown toward the rows by the cultivator blades, but do not attempt to ridge or hill the potatoes by hilling blades or the shovel plow. From seven to nine cultivations have been found most advantageous for the crop, and it is well if the tillage is continued into August. Level tillage has given better results on the station grounds than the "hilling" method, the advantage being greater in dry seasons.

Compare the area thus tilled with another that is "laid by" at about the third cultivation, which may be either hilled or left level.

6. *Protection against blight v. protection against beetles only.*—For a description of the insect and fungus enemies that prey upon the potato, and their remedies, the reader is referred to Bulletin 140, pages 391, 403 (copies may be had upon application). It may be said, however, that no matter how thoroughly the preparation and tillage of the soil, unless a healthy foliage is maintained, satisfactory results can not be secured. In the trials on the station grounds in 1897 the gain due apparently to the use of Bordeaux mixture was 71 bushels per acre. In some seasons it might be more, in others less, according to the prevalence of the blights. A trial of Bordeaux mixture is earnestly recommended, but it is desired that no one will refrain from undertaking the tillage experiment because he is unprepared or unwilling to use the Bordeaux mixture. Bulletin 156 contains revised instructions for making Bordeaux mixture.

The best results have been obtained on the station grounds by combining the twice plowing (autumn and early spring) with deep planting, in thoroughly fitted soil; prolonged, frequent, and level tillage, and spraying with Bordeaux mixture and Paris green.

It is not expected that each experimenter will be able to follow these suggestions in all their details, but that he will endeavor to secure the conditions described in one or more of the various experiments named above as near as the circumstances will permit.

This experiment has been very helpful in inducing farmers to adopt improved methods of potato tillage. Cornell Bulletin No. 191, "Tillage experiments with potatoes," summarizes many reports on this experiment sent in by the farmers.

(2) As an example of a cooperative experiment that is chiefly investigational in character, though it was watched by many farmers in the locality where it was carried on and therefore was also instructional, we will take the investigation of the cause of "shelling" of grapes.

A—The experiment station.

B—The farmer.

B reports that for several years his grapes and those of his neighbors have fallen off before ripening. The trouble has been so general that it has received the local name of "shelling" of grapes.

A sends an officer to investigate. The officer reports that the trouble is probably due to a soil difficulty, probably an insufficiency or an excess of some element of plant food.

A proposes an experiment in which fertilizers are to be used on grapes in that vicinity. The experiment is to be carried on under the following conditions: B shall furnish 1 acre of vines. He shall receive, transport, and apply fertilizers under direction of A. B shall also harvest and record yields of grapes from the different plats under direction of A

The plan of the experiment is made in duplicate and agreed to by A and B. The work progresses. The experimental plats are visited from time to time by A.

The work is carried on for two years, and it is found that the shelling of grapes in that particular instance is due to a deficiency of potash in the soil.

VALUE OF COOPERATIVE EXPERIMENTS.

The benefits resulting from cooperative experiments may be stated in a general way as threefold: (1) The acquisition of new data relating to problems in practical agriculture that are under investigation; (2) the educational effect of the experiment, and (3) the bringing of college and station into closer relationship with the farmers.

1. *The data obtained.*—It is true that all difficult and highly scientific investigation needs at all times to be under the direct observation and management of carefully trained scientific men, and therefore is best undertaken at the station. But often the problems to be studied are not located at the station and can not be brought there. They must be investigated where they occur. If the farmer simply affords the station an opportunity to study a problem that occurs on his property, it can scarcely be spoken of as cooperative investigation. If, however, the farmer not only gives access to his property, but sacrifices some portion of it for the experiment or contributes time and labor to it, the experiment is cooperative. Thus broadly interpreted, cooperative experiments have yielded some of the most valuable results achieved by the Cornell Station. Experiments of this class have been chiefly along the line of seeking remedies for the insect, fungus, and bacterial pests that prey upon the farmer's crops and live stock.

The experiment stations by years of careful work have accumulated a vast amount of data that is of inestimable value to scientific and practical agriculture, and farmers everywhere are coming more and

more to look to the stations and colleges for the solution of their difficult problems and for advice when undertaking any new agricultural enterprise. But differences in soil, climate, or facilities for work often render it uncertain whether the results obtained on the station and college grounds will be verified in actual practice on the farms throughout the State. This is particularly true in regard to experiments with fertilizers. It is now universally conceded that the only way a farmer may know what constituents of commercial fertilizers, if applied to his soil, will produce an increase of crop is by making a trial on small areas with the various chemicals and carefully noting the result. Furthermore, it is known that a field at one time well supplied with a particular element of plant food may, by cropping or bad management, become depleted in the same. Hence one experiment with fertilizers on a certain soil will not suffice for all time, but must be repeated at intervals if the farmer is to treat his soil intelligently and to secure profitable returns.

It is therefore important that arrangements be made whereby farmers may make soil tests with fertilizers at small expense and have instruction and assistance so that the results shall be trustworthy guides in actual farm practice. Such assistance the Cornell Station endeavors to afford.

Again, it is well understood that a difference of yield equal to 25, 50, or even 100 per cent often results simply from a difference in the variety of the crop grown, but these varietal differences are not constant in different parts of the State. The station is constantly making more or less variety tests, but not to the extent that would be done if it were felt that results obtained on the home grounds were of certain application to large and widely separated areas throughout the State. It is believed to be the better policy for the college to encourage and assist the farmers to make tests on their own soils of recommended varieties of the crops they grow. The same is true in regard to the introduction of new crops or those that have not heretofore become widely disseminated throughout the State.

2. *Educational value of experimental work.*—As previously stated, many farmers do not read the bulletins published by the stations, or, if they read them, are not sufficiently impressed with the suggestions contained therein to be led to endeavor to put them to a practical test. What they see upon their own or their neighbor's farm has much more influence with them than what they read concerning results obtained at the college farm; hence the desirability of every farm being, to a certain extent, an experiment station. Not only are the facts made more real, but the educational effect of an experiment upon the persons conducting or observing it is of no small importance. Probably no one thing will account so much for the failures among farmers as

the lack of habits of accurate observation. They guess at results or judge by appearances instead of making accurate weights or measurements. They will judge the effect of a certain fertilizer, for instance, more by the appearance of the straw or vines than by the yield of grain or potatoes, which are seldom accurately known. A difference in yield of 50 bushels per acre of potatoes will scarcely attract attention as they lie in their places on the ground after digging. Probably nothing would contribute more to increased financial success among farmers than a development of habits of accurate observation and the thoroughness to carry an investigation through to a definite conclusion. Too often the farmer is satisfied to accept appearances as "judged by the eye" instead of spending time and effort to make accurate weights and measurements. After some experience in experimental work farmers come to know that "judging by the eye" is entirely unreliable, and they adopt more accurate methods, much to the advantage of their business.

That the educational effect of the cooperative experiments is not confined to the persons conducting the experiments is nicely shown by the following extract from one of the reports on methods of potato tillage:

> One of my neighbors, last spring when I was planting, stood and saw the way I was doing it, and when he came to see a furrow from both sides turned over on top of the potatoes that had been dropped he went off in disgust without saying a word to me, but he said to another fellow, who told of it, "I did suppose that Ingalls had fair judgment; he seems to have about other things, but I guess he has read a little too much about farming for his own good." Well, that fellow kept watch of the potatoes all summer. They were where he had to go right by them every day, and he was there when I dug them. He then said, "Well, George; I'll give it up. I thought when you were planting them that you were throwing away a good deal of time and the use of a good piece of ground, but I want to try a piece myself next year the way you planted this."

3. *Closer relations between farmers and the college and station.*—Aside from the value of the data obtained and the educational effect upon the farmer, these experiments are valuable as a means of bringing the college and the farmers into closer relationship. The college and station staff need to know more of the farmer's successes and failures and of the problems that are perplexing him It is thus enabled to direct its investigations along lines that will be more directly helpful to the agriculturists of the State. The farmers, as well, by reason of personal association with college representatives, come to appreciate more fully what the college can do for them and where to go for help when difficult problems arise.

In conclusion, I present a letter written by Prof. I. P. Roberts, director of Cornell University College of Agriculture and Agricultural Experiment Station and of the University Extension Work in

Agriculture, in answer to an inquiry as to his estimate of the value of cooperative experiments as a means of investigation and of instruction:

I cheerfully comply with your request to give my opinion as to the beneficial results of our efforts to cooperate with the farmers of New York in discovering more rational and economical methods of tillage and of the production and maintenance of plants and animals. The methods by which certain results are secured on the college farm are not always applicable when applied to different soils or to land situated in a climate quite different from ours; therefore, we have located many hundred plats throughout the State which have been devoted to testing the applicability of certain methods of tillage and of fertilizing and the adaptability of certain varieties of plants and their treatment during the growing and fruiting periods.

The results of these efforts have been most gratifying. Many hundred farmers have learned by reason of this cooperative work to see many things which they had never observed before. They have acquired a knowledge of many facts which were unknown to them before this work was undertaken. They have come to have a greater interest in and respect for their profession than formerly. These cooperative experiments have stimulated those who have entered into them to study the literature bearing upon their business; in fact, with scarce an exception, these men have become students and call loudly for instruction. A successful effort has been made to meet this demand by the establishment of the farmers' reading course, which extends through three years and which now has an enrollment of over 20,000 pupils. This work has brought the farmer and the teacher into close touch and has broken down prejudices which formerly existed. Our efforts in this direction have resulted in such varied and widespread benefits that I do not hesitate to answer yes to your question and recommend that this or similar work be undertaken in your State.

The question has been asked, "Are these cooperative investigations conducted with sufficient accuracy to justify the publication of results?" In some cases they are, and in some cases they are not. They come under the same general rule that must always be applied to experiments conducted by trained experimenters. Perhaps not more than one-fourth of the results secured through experiments conducted by the stations' staffs have ever been published or ever should be. The logical method of improving agriculture is to improve the agriculturist, and the logical and almost the only way to help him is to "help him to help himself."

I only regret that we have not the means to increase our cooperative work many fold, for we must go to the farmers, since they can not come to us, if our efforts to promote a more rational and lucrative agriculture bears abundant fruitage.

COOPERATIVE EXPERIMENTS IN ONTARIO, CANADA.

By C. A. Zavitz, B. S. A.,

Experimentalist at the Station of the Ontario Agricultural College, Director of Cooperative Experiments in Agriculture, and Secretary of the Ontario Agricultural and Experimental Union.

Cooperation is a prominent feature in the agricultural experimental work in Canada. It may, in general, be classified under three headings: (1) Cooperation among the experiment stations, as in the case of the five stations under the control of the Dominion government; (2) cooperation among the branch stations, as the work of the 13 substations under the direction of the Ontario Agricultural College, and (3) cooperation among the farmers, as is seen in the experiments

under the supervision of the Ontario Agricultural and Experimental Union. The work embraced under each of these three headings increases the value of the results of the experiments conducted at the stations, and that embraced under the last heading contains many additional features of great value which are not furnished by either of the others. This article is confined to the cooperative experimental work among the farmers, as conducted by the Ontario Agricultural and Experimental Union.

It should be clearly understood that the system of cooperative experiments here described is very different from a system of seed distribution where no systematized plans are given for conducting definite work and for reporting exact results. I claim that the former has many commendable features not furnished by the latter and that the latter has some objectionable features not included in the former.

ORIGIN OF THE PRESENT SYSTEM OF COOPERATIVE EXPERIMENTS IN ONTARIO.

The Ontario Agricultural College and Experimental Farm was established at Guelph in 1874 by the government of the Province of Ontario. Experimental work was commenced in the spring of 1876, and has gradually increased in extent and in value from that day up to the present time. Experiments and investigations are now conducted at the college along many lines of practical and scientific agriculture embraced under the general headings of plant production, animal production, and agrotechny. In the experiments in agronomy upward of 2,000 plats (Pl. XLVII, fig. 1) are used annually in growing grains, roots, potatoes, fodders, grasses, and clovers to obtain information regarding the best varieties, the most productive selections of seed, the best dates of seeding, the most improved methods of cultivation, the most economical ways of increasing the fertility of the soils, etc.

In 1879 the officers, ex-students, and students of the Ontario Agricultural College formed themselves into an association under the name of the "Ontario Agricultural and Experimental Union." The objects of the association were "to form a bond of union among the officers and students, past and present, of the Ontario Agricultural College and Experimental Farm; to promote their intercourse with the view to mutual information; to discuss subjects bearing on the wide field of agriculture with its allied sciences and arts; to hear papers and addresses delivered by competent parties, and to meet at least once annually at the Ontario Agricultural College."

At the beginning of the year 1886 experiments had been carried on at the college for a period of ten years. The information thus obtained formed an excellent foundation for the establishment of a system of cooperative experiments among the farmers of Ontario.

FIG. 1.—A PARTIAL VIEW OF THE 2,000 FIELD PLATS AT THE ONTARIO AGRICULTURAL COLLEGE.

FIG. 2.—FORTY EXPERIMENTAL PLATS ON THE EXHIBITION GROUNDS AT WHITBY, ONTARIO.

There was no way in which this could be brought about better than through the medium of the Experimental Union, which was comprised of energetic young men who had had the advantage of the training at an agricultural college and had become familiar with accurate methods of conducting experimental work. A committee was therefore appointed by the Experimental Union to assist in getting a plan of cooperation established. The writer of this article, who had charge of the experiments in agronomy and live stock at the college, was appointed director of the cooperative experiments in addition to his other duties. Letters were written to members of the union and twelve consented to conduct experiments with fertilizers and field crops on their own farms in the year 1886.

DEVELOPMENT OF THE COOPERATIVE WORK.

The cooperative work, which was started in 1886, has had a steady and substantial growth from that date to the present year. At first it was confined to the testing of field crops and fertilizers. Other branches of agriculture, however, were added from time to time until no less than ten different lines of work have been included in the general plan. Cooperative work was organized and started in these various departments of agriculture as follows:

1. Field crops and fertilizers	1886
2. Horticulture	1888
3. Dairy husbandry	1889
4. Apiculture	1889
5. Live stock	1890
6. Economic entomology	1892
7. Economic botany	1893
8. Soil physics	1897
9. Poultry raising	1899
10. Forestry	1901

Under five of these headings, work has been conducted continuously since it was first started. In the other branches, however, it has been somewhat irregular, owing to various reasons. Cooperative experiments in agronomy have now been conducted throughout Ontario for a period of seventeen years, and those in horticulture for a period of fifteen years. The work in each of these lines, which had a small beginning, has become very extensive, comprehensive, and valuable.

CHARACTER OF THE WORK OF THE EXPERIMENTAL UNION.

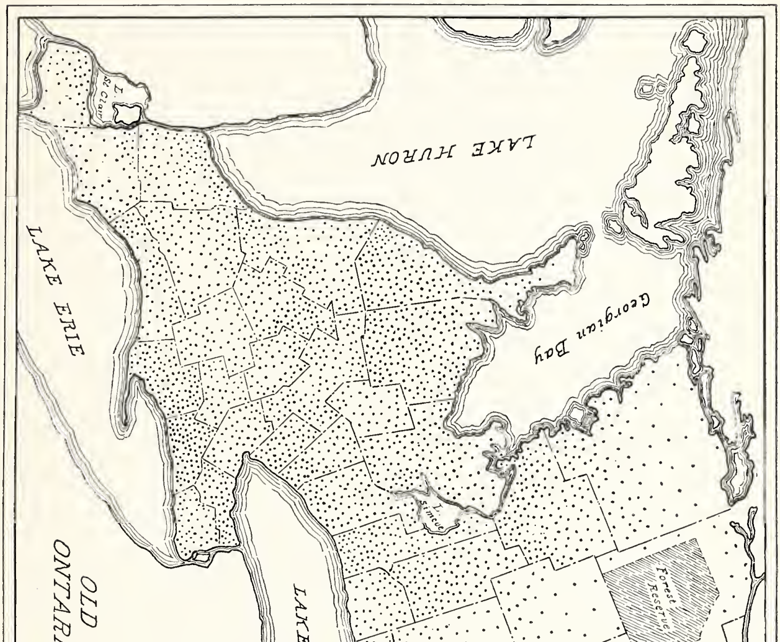
The cooperative experimental work is operated conjointly by the Ontario Agricultural College Experiment Station and the Ontario Agricultural and Experimental Union. The great bulk of the cooperative experiments have been conducted by the farmers themselves upon their own farms. Recently, however, the union has secured the cooperation of the directors of some of the agricultural societies, and

experimental crops have been grown on the exhibition grounds, which form object lessons of great interest at the time of the "fall fairs" (Pl. XLVII, fig. 2). The officers and members of the farmers' institutes have also become interested in the experimental work and in some instances have united in carrying out a large number of the cooperative tests in connection with the local organizations. Besides these, various seedsmen, editors, and school-teachers have taken up the work with a good deal of enthusiasm and have obtained object lessons and definite information, both of which have proven valuable. It is quite probable that the work through these different avenues will be considerably increased in the near future. As the greatest amount of the union work, however, has been carried out on the individual farms, it is this phase of the cooperative plan which is receiving particular attention in this article.

The union opens up a channel through which some of the best material of the experiment station can be brought to the homes of the farmers; it makes direct application of the information gained at the station by having experiments conducted on hundreds and even thousands of farms; and it systematizes the cooperative work in such a way that the results of those experiments which have been conducted with care and accuracy can be summarized and made into valuable reports for the guidance of farmers generally. Perhaps the greatest advantage of the cooperative experimental work in Ontario is that it helps the farmers to help themselves. It combines in an admirable way the training of the hands and the training of the intellect, and is one of the greatest educational features which has been introduced throughout the rural districts of Ontario in recent years.

Great care is exercised in planning the various cooperative experiments in such a way that they can be successfully undertaken by the people who are to be benefited thereby. Some experiments are simple, and some are more complicated, but in every case the work is made as clear of comprehension, as definite of purpose, and as simple in method of operation as is consistent with the objects desired. It is the constant aim to make all experiments as interesting, as valuable, and as instructive as it is possible to make them. It is probably due to the care taken in the selection and the planning of the experiments, and to the kindly interest manifested toward the experimenters themselves, that the cooperative work has become so extensive in its operations, so popular among the people, and so far-reaching in its results.

The results of experiments and investigations carried on at the experiment station form the basis for the selection of the materials used for the cooperative experiments. These materials consist of seeds, plants, bees, chemicals, fertilizers, thermometers, rain gauges, etc., which are forwarded to the experimenters by mail, by express, and by freight.



Each Dot Indicates a Co-operative Experiment in Field Agriculture in 1902.

MAP SHOWING COOPERATIVE EXPERIMENTS IN ONTARIO.

Printed instructions for conducting the experiments and blank forms on which to report the results are furnished to every person undertaking the work. Personal letters are also used frequently to give encouragement and friendly advice to those especially who are entering upon the work for the first time.

Reports of the cooperative tests are very carefully examined, and those which are complete and which show carefulness and reliability throughout are summarized. The average results and the special features of the various experiments are presented and discussed at the annual meeting of the Experimental Union. The results thus presented, along with the discussions thereon, are printed in the annual report of the union, of which about 40,000 copies are issued and distributed among the experimenters and among the farmers generally.

NUMBER OF EXPERIMENTERS.

The number of experimenters engaged in the cooperative work has increased from 12 in 1886 to 3,787 in 1902. In agronomy alone there have been 27,706 distinct tests made throughout the province since the work was started seventeen years ago. These tests have required about 140,000 separate plats. The increase in the number of experimenters in agronomy can be seen from the following figures, which show the exact numbers actually engaged in the work in each of several years: 1886, 12; 1887, 60; 1888, 90; 1891, 203; 1892, 754; 1894, 1,440; 1896, 2,425; 1901, 2,760, and 1902, 3,135 (Pl. XLVIII). In horticulture the cooperative work was taken up by 15 experimenters in 1888 and by 480 experimenters in 1902.

HOW THE COOPERATION OF THE PEOPLE IS SECURED.

In the spring of each year circulars outlining the cooperative work are distributed by the various committees appointed by the Experimental Union. Those asked to take part in the scheme of cooperation may be classified as follows: (1) The officers and students, past and present, of the Ontario Agricultural College, who pay an annual fee of 50 cents and have control of the executive work of the Experimental Union; (2) the experimenters of former years who have done satisfactory work; (3) leading farmers, gardeners, and others, whose names have been suggested by secretaries of farmers' institutes, secretaries of agricultural societies, principals of collegiate institutes, inspectors of public schools, and others; and (4) various persons who have seen the experiments of other people, or have in some way heard of the work and wish to assist in the movement by conducting experiments on their own farms. The circulars are distributed in the order here given, starting first by sending to those who have been connected with the college and are therefore trained for the work and finishing the dis-

tribution by sending to those engaged in some branch of practical agriculture who have not conducted experiments previously, but who wish to undertake the work.

THE EXTENT TO WHICH THE EXPERIMENTERS ARE DIRECTED AND CONTROLLED BY THE CENTRAL AUTHORITY.

From the beginning the cooperative experimental work of the union has been directed and controlled by circulars and letters, printed and written, which have been transmitted through the mails. When personal visits have been made to the experimenters the object has been to enable the director to study the difficulties of those actually engaged in the work, and thus to be in a better position to know the best methods to adopt in the printed instructions, rather than to take any part in the immediate control of the practical operations of the experiments. The work of each committee is largely in the hands of the director, who is generally a member of the staff of the experiment station, and is thus in a good position to unite the work of the station and the work of the union, so that each is made better by the help of the other.

Most persons are asked to sign an agreement when applying for an experiment. The following agreement was the one used in 1902 in connection with the cooperative work in agronomy:

> I would like to conduct experiment No. ———, but if all the material for that experiment has been applied for before my application is received I select experiment No. ——— as my second choice. If the material for one of these two experiments is forwarded to me, I will endeavor to—
>
> (1) Carry on the test according to the instructions received with the seed;
>
> (2) Exercise care and accuracy in the work; and
>
> (3) Report the results of the experiment as soon as possible after harvest, whether successful or not.

Every man is made responsible for his own experiment and is urged to do the very best he can for himself, for his neighbors, and for the union. Many persons who at first took but little interest in the experiments have afterwards proven themselves to be most valuable experimenters and have shown great care and accuracy in the details of their work. The names of those who conduct the experiments with the proper amount of care and accuracy are placed on the list of successful experimenters, and these individuals are carefully looked after in the future. It will therefore be seen that the Experimental Union makes a study of the men themselves, as well as of the products of their labor. The education of the men in the development of accurate methods, careful observation, and a deeper interest in the occupation of farming is one of the objects of the cooperative experimental work in Ontario. I have no hesitation in saying that the results which have been obtained along this line are of far greater value than the entire cost of the cooperative work of the past seventeen years.

ALL VOLUNTEER EXPERIMENTERS.

No direct financial help is offered any person to undertake and carry through the cooperative work. It is purely a volunteer movement from the start to the finish. The materials for the experiments, the instructions for making the tests, and the blank forms for reporting the results are furnished free of charge to those who ask to join in the work and who sign the agreement furnished by the union. Experimenters in crop production use the soil on their own farms, conduct the experiments themselves, and report the results to the director of that particular branch of cooperative work in which they have enlisted. In those experiments in which crops are produced the produce is retained by the experimenters as their personal property, except any small quantities which are returned to the college as samples.

In the departments of agronomy and horticulture the volunteer experimenters in 1902 comprised both men and women, highly educated and self-educated, old and young, married and single, rich and poor, who did the work for their own good and for the good of others. About two thousand of them had become trained in the work from their experiences in conducting experiments in previous years. Some of the volunteer experimenters have carried on their tests with great skill and accuracy and have reported the results of their valuable work in each of eight, nine, ten, and even a dozen years.

COST OF THE WORK AND HOW IT IS PAID.

The cost of the cooperative experiments is paid conjointly by the station and the union. The station pays for most of the labor and for some of the material, and the union for all of the stationery, printing, postage, expressage, etc., as well as for part of the material required to carry on the cooperative work.

The union receives an annual grant from the government, which is increased from time to time. The first government grant to the union was $75, made in 1888, and the last government grant was $1,400, made in 1902.

All the executive work of the Experimental Union is confined to the officers and students, past and present, of the Ontario Agricultural College, who pay an annual fee of 50 cents. The fees now collected in this way amount to about $150 annually.

The total annual income of the Experimental Union is therefore about $1,550 at the present time. The amount devoted to the cooperative work in 1902 was $1,222.99. The remainder was used for advertising and reporting the annual meeting, paying speakers from a distance, paying the salary of the secretary, etc.

The total amount of money furnished by the union for the experiments in agronomy for the past seventeen years is $7,528.20. The amount required for the work has, of course, been increased according to the development of the work, as will be seen by the following

amounts used in various years: 1886, $5.80; 1889, $67.35; 1893, $414.88; 1897, $676.60; 1900, $809.61; and 1902, $910.22. It is stated by the leading agricultural authorities in Canada that no government money is used to a better advantage than that devoted to the cooperative experiments along the various lines of agriculture as carried out by the Ontario Experimental Union.

OUTLINE OF THE COOPERATIVE EXPERIMENTS IN 1902, WITH SPECIAL REFERENCE TO THOSE IN AGRONOMY.

In 1902 cooperative experiments were conducted by the union in agronomy, horticulture, economic botany, poultry raising, and forestry. There were in all 41 separate and distinct lines of work taken up by 3,787 experimenters. Of this number 31 were in agronomy, and included spring and fall grains; root crops; forage, fodder, silage, and hay crops; culinary crops; methods of cultivation; preparations of seed; and applications of commercial fertilizers and farmyard manures. The following is the list of cooperative experiments in agronomy conducted by more than 3,000 Ontario farmers in 1902:

List of cooperative experiments in agronomy.

Number of experiment.	Experiments.	Number of experimenters.
	SPRING AND FALL GRAINS.	
1	Testing 3 varieties of oats	495
2	Testing 3 varieties of 6-rowed barley	99
3	Testing 2 varieties of hull-less barley	69
4	Testing emmer and 2 varieties of spring wheat	164
5	Testing 2 varieties of buckwheat	12
6	Testing 3 varieties of field peas for northern Ontario	96
7	Testing two varieties of bug-proof field peas	273
8	Testing cowpeas and 2 varieties of soy, soja, or Japanese beans	55
9	Testing 3 varieties of husking corn	179
31	Testing 3 varieties of winter wheat	201
	ROOT CROPS.	
10	Testing 3 varieties of mangolds	92
11	Testing 2 varieties of sugar beets for feeding purposes	77
12	Testing 3 varieties of Swedish turnips	25
13	Testing kohl-rabi and 2 varieties of fall turnips	7
14	Testing parsnips and 2 varieties of carrots	39
	FORAGE, FODDER, SILAGE, AND HAY CROPS.	
15	Testing 3 varieties of fodder or silage corn	40
16	Testing 3 varieties of millet	11
17	Testing 3 varieties of sorghum	11
18	Testing grass peas and 2 varieties of vetches	18
19	Testing Dwarf Essex rape and Thousand Headed kale	14
20	Testing 3 varieties of clover	10
21	Testing sainfoin, lucern, and burnet	16
22	Testing 5 varieties of grasses	10
	CULINARY CROPS.	
23	Testing 3 varieties of field beans	47
24	Testing 3 varieties of sweet corn	107
	FERTILIZER EXPERIMENTS.	
25	Testing fertilizers with corn	24
26	Testing fertilizers with Swedish turnips	14
	MISCELLANEOUS EXPERIMENTS.	
27	Growing potatoes on the level and in hills	56
28	Testing 2 varieties of very early potatoes	770
29	Planting cut potatoes which have and which have not been coated over with land plaster	45
30	Planting corn in rows and squares	59

Most of the plats were 1 rod wide by 2 rods long, being exactly one-eightieth of an acre in size. The largest plats used in 1902 contained 16 square rods, or one-tenth of an acre, each. Formerly some of the plats were one-half of an acre in size, but these gave less satisfaction than the smaller plats. It is quite probable that cooperative experiments with pasture crops will be started in the near future, and these will, of course, require plats of a very much larger size.

A DETAILED DESCRIPTION OF A TYPICAL EXPERIMENT.

Nearly all of the 41 cooperative experiments in 1902 required different instructions for carrying out the work and different blank forms on which to report the results. As an illustration of one of the least complicated experiments, however, a description is here given of experiment No. 1, the testing of three varieties of oats:

General instructions for all the experimenters in agronomy.

Make the plats exactly the right size; observe great accuracy in the work throughout; keep the plats clean and tidy; examine the experiment frequently; compare one crop with another; invite your neighbors to see the test, and discuss the results with your friends, in your local newspaper, and at the meetings of your farmers' institute, and you will surely enjoy the work, glean information for yourself, and have the great satisfaction of knowing that you have tried to do good to others.

Special instructions for experiment No. 1.

(1) Be sure and do not leave out any variety belonging to the experiment.

(2) For sowing on an extra plat for comparison, carefully weigh out a similar quantity of your own seed of the very best variety that you have ever grown on your farm.

(3) Wooden stakes painted white, on which the names of the varieties are plainly written with a lead pencil, answer nicely for labels.

(4) Wooden stakes 2 inches square and 2 feet long, with the lower ends sharpened, are very suitable for driving in the ground at the four corners of each plat.

(5) For your experiment be sure and select soil which is very *uniform* throughout and which is about the average quality of your farm.

(6) Locate the experiment some distance away from buildings and trees in order to prevent any injury by poultry or birds, or by the shade or the roots of trees, etc. Try to have your experiment near the public road, where it can be seen by the people who pass by.

(7) Cultivate and harrow the land thoroughly, and thus make a seed bed which is fine and uniform throughout. Work enough land to allow for a path 3 feet wide between each two plats.

(8) *Carefully measure four uniform plats, each plat being exactly 2 rods (33 feet) long by exactly 1 rod (16½ feet) wide.*

(9) Drive the wooden stakes at the four corners of each plat and leave a clean path 3 feet wide between each two plats.

(10) Place a cord tightly around each plat and sow the different varieties upon their respective plats, not forgetting to sow your own seed on one of them.

(11) As soon as the seed is properly sown and carefully covered drive the labels securely along the sides of their respective plats.

(12) After the plants are up 2 or 3 inches again run the cord around each plat and cut off every plant outside of the line.

(13) Cut each variety as soon as it is ripe, and when it is dry take it to the buildings and *weigh* it carefully in order to get the weight of the whole crop of each variety.

(14) Carefully thrash each variety with a flail immediately after it is taken in from the heat of the sun, and use great care in securing the *exact weight of the cleaned grain of each variety.*

(15) Examine your report carefully and see that all the facts of the experiment are entered correctly.

(16) Make a copy of the report and keep it yourself for future reference.

(17) Kindly forward the report to C. A. ZAVITZ, *Agricultural College, Guelph, Ontario*, as soon as possible after harvest.

Blank form for experiment No. 1, to be filled out and forwarded to the director.

Varieties.	Date of seeding.	Date of maturing.	Strength of straw.	Amount of rust.	Amount of smut.	Weight of whole crop on each plat.	Weight of grain on each plat.	Nature of soil.	Cropping in previous year.	How and when last manured.
....	....	....	....	....	....	....	....			
....	....	....	....	....	....	....	....			
....	....	....	....	....	....	....	....			

Was this test made according to the printed instructions?..

....

For your system of farming, which variety do you consider best?..

Second best?.................................... Poorest?....................................

What are your reasons for valuing the crops in the order here given?..

....

....

Township..County..

Name ....P. O ....

Date of mailing this report to C. A. ZAVITZ, *Agricultural College, Guelph, Ont*..........................

Upward of 200 varieties of oats have been tested at the experiment station for at least five years. The three varieties used for the cooperative experiments for 1902 were selected as the most promising varieties for cultivation in Ontario. These varieties possessed different characteristics, however, which would adapt them to different

kinds of soil. By the cooperative tests each experimenter was thus enabled to find out for himself which one of these three leading varieties would give the best results upon the soil of his own particular farm. The summary results of the 92 complete reports of carefully conducted experiments which were received in the autumn of 1902 showed which variety made the best general record throughout the whole of Ontario or in certain sections of the province.

The following is the summary of the cooperative experiments with the varieties of oats as taken from the last annual report of the Ontario Agricultural and Experimental Union:

Summary of cooperative experiments with varieties of oats.

Experiments.	Varieties.	Comparative value.	Yield per acre.	
			Straw.	Grain.
			Tons.	*Bushels.*
1. Oats (102 tests)	Siberian	100	1.3	42.2
	Improved Ligowa	88	1.2	40.5
	Daubeney	52	1.1	36.9

Each experimenter was asked to give the relative value of each variety as the result of the experiment conducted on his own farm. In the first column of figures, therefore, in the table here presented the highest results of the comparative value of the different varieties are given, 100 representing the most popular variety in each experiment. The yield of straw as here reported means the total crop less the amount of grain, and this would, of course, include the chaff with the straw. The yields of grain are given in numbers of bushels per acre by weight and not by measure, the standard weight of oats in Ontario being 34 pounds per bushel.

It will be seen from the results here presented that the Siberian variety of oats occupies first place among the three varieties in popularity and in yield of grain per acre. The Siberian oats also occupied first place in yield of grain per acre in the average results of 125 experiments in 1892, 105 experiments in 1893, 121 experiments in 1894, 78 experiments in 1895, 106 experiments in 1898, 107 experiments in 1899, and 97 experiments in 1900; and it occupied second place in yield of grain per acre in 1896 and in 1897. Not only has the Siberian variety, therefore, given good results at the agricultural college, but it has also made a very excellent record throughout Ontario. In each of the past two years each experimenter was asked to sow an extra plat with the variety of oats which had proven the best in his past experience. The American Banner variety was used as the extra variety by 16 experimenters in 1900, and also by 16 experimenters in 1901. In taking the average results of these different experiments in each of the two years, we find that the Siberian gave 2.6 bushels per acre more than the American Banner in 1900 and 2 bushels per acre

more than the American Banner in 1901. It will therefore be seen that the Siberian has not only given a larger yield of grain per acre than that produced by the American Banner in the average results of twelve years' experiments at the agricultural college, but it has also given a larger yield in the cooperative experiments over Ontario in each of the years that these varieties have been tested with each other.

The Siberian oats were imported from Russia in 1888 by the Ontario Agricultural College, and are now one of the two most popular and most extensively grown varieties throughout the province. Two and a half millions of acres of oats are grown in Ontario annually. The area now devoted to the cultivation of the Siberian variety probably approaches one-quarter of this amount. The Siberian oats which are now grown in Ontario have resulted from the crop produced in 1889 on a plat exactly one one-hundredth of an acre in size. After the variety had been carefully tested at the college for a period of three years along with 80 other kinds of oats, it was distributed throughout Ontario for cooperative experiments through the medium of the Ontario Agricultural and Experimental Union.

Many additional comments might be made in reference to important features of the summary results of this one experiment with oats. For instance, nothing has been said about the comparative earliness, the strength of straw, the amount of rust, and the amount of smut of each variety. Comparisons might also be made between the results of the varieties distributed and those of various other varieties used in the tests.

According to the reports of the experimenters, upward of 25,000 people saw the cooperative experiments with oats in 1902. All such experiments as the one here described open up most interesting fields of study and investigation for those who are associated either directly or indirectly with this great work.

THE VALUE OF THE COOPERATIVE EXPERIMENTS IN ONTARIO.

The writer of this article had strong faith in the value of cooperative experiments, even before they were started in Ontario in 1886. His experiences of the past seventeen years as a director of the cooperative work in Ontario and as a personal visitor to more than 100 agricultural colleges and experiment stations in Europe, in the United States, and in Canada have even increased his faith in the great value of the work. It is a work which has been fruitful in promoting agricultural science, in increasing agricultural investigations, and in diffusing practical information among the farmers of Ontario. It has led the farmers to feel that the experiment station is working for their good, and has thereby caused a deep interest in the work of both the station and the college. The interest in the institution is shown by the fact that the station was visited by Ontario farmers to the number

of about 23,000 in June, 1900; 28,000 in June, 1901, and 31,000 in June, 1902. The work has helped to overflow the college with an attendance of upward of 500 agricultural students annually.

It is indeed a difficult task to attempt to enumerate on paper all of the advantages derived from a carefully arranged system of cooperative experimental work. The system in operation in Ontario is exerting an influence which is wholesome in its character, extensive in its operation, and far-reaching in its results. It deals with the agriculturists themselves, as well as with materials used in agriculture—with living, thinking, active men, as well as with fertilizers, soils, plants, trees, and animals. Its tendencies are to improve men and to help men to improve agriculture.

A SUMMARY OF SOME OF THE ADVANTAGES OF COOPERATIVE EXPERIMENTAL WORK.

(1) It trains the best men of the country, including the college graduates, to help in the solution of scientific problems which arise in connection with the various departments of agriculture.

(2) It furnishes a post-graduate course for young men after returning home from college.

(3) It forms a bond of union between the college graduates and their alma mater, as well as among the graduates themselves.

(4) It gives the graduates of an agricultural college an excellent opportunity for exerting a good influence in their respective neighborhoods.

(5) It establishes a sympathetic spirit between the workers at the experiment station and the workers throughout the country.

(6) It enables both the station and the college officers to know better the real needs of the agriculture of the present day.

(7) It makes a practical application of many of the results of the experiment station.

(8) It helps to check some of the experiments of the central station by having similar experiments duplicated on hundreds of farms under different conditions of soil and climate.

(9) It distributes the very best seeds, plants, fertilizers, etc., among the best men and then teaches the men to experiment and to investigate.

(10) It systematizes seed distribution along definite lines and for valuable purposes.

(11) It helps the farmers to help themselves.

(12) It educates along the lines of careful handling, close observation, accurate calculation, and economical methods.

(13) It trains men to unite science with practice and to lead other men to do likewise.

(14) It helps farmers to understand better the scientific principles that they read about in bulletins, reports, and newspaper articles and that they hear about at agricultural meetings.

(15) It supplies a direct as well as an indirect source of information for the farmers.

(16) It enables practical men to obtain information regarding varieties of field and garden crops, selections of seed, dates of seeding, methods of cultivation, ways of increasing soil fertility, etc., for their own particular farms which they could not get in any other way.

(17) It enables farmers to get a supply of pure seed of the leading varieties of grains and potatoes, which rapidly increases in quantity, and thus furnishes seed for sowing and planting on large areas and for selling at good prices.

(18) It provides a wholesome and an attractive bill of fare for the farmer's table by encouraging the cultivation of small fruits.

(19) It works successfully in nearly every branch of agriculture.

(20) It penetrates into those parts of the country where agricultural advancement is ordinarily very slow.

(21) It furnishes hundreds and even thousands of object lessons annually, which form centers for interesting study along the lines of progressive agriculture.

(22) It supplies valuable topics and results for discussions in the field, at the fireside, in the corner grocery, and at meetings of farmers' institutes.

(23) It stimulates the local newspapers to take a deeper interest in advocating better methods of farming.

(24) It furnishes some exceedingly important results for printing and distributing in the form of bulletins and reports.

(25) It adds dignity to farming and pleasure to farm life.

(26) It exerts a wholesome influence in keeping the farm boys interested in farm work.

(27) It increases the popularity of the agricultural college, and undoubtedly adds largely to the number of students in attendance.

(28) It develops a keen interest in the work of the experiment station.

(29) It leads to a substantial increase in farm profits and to a steady advance in agricultural education throughout Ontario.

INDEX OF NAMES.